# Standardization of Ship Materials

BY

FRED T. LLEWELLYN
*Federal Shipbuilding Company, Kearney, N. J.*
*Chickasaw Shipbuilding Company, Mobile, Ala.*



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Fred T. Llewellyn

Federal Shipbuilding Co., Kearny, N. J., & Chickasaw Shipbuilding Co., Mobile, Ala.

1. It will be the aim in this paper to present a brief outline of the need, history, and possibilities of standardization in connection with some of the materials used in the construction and equipment of steel cargo ships. The paper is supplemented by five appendices, which will not be read, but whose examination, it is believed, will support the conclusions reached.

2. For all practical purposes "standardization" does not mean "making everything alike"—that is "imitation." The term signifies rather "regulation in accordance with a series of common criteria," and the efficiency of the standardization varies inversely with the profusion of the criteria and directly as the breadth of their applicability. There are at least three different phases of standardization as applied to ships—standardization of types, which is largely the owner's or operator's affair; standardization of designs, in which the shipbuilder is principally concerned; and standardization of materials, which is most vital to the manufacturer—and while all three phases are to some extent inter-related it is desirable not to confuse their respective scopes. The possibilities of standardizing the various types of ships may be limited by differing conditions of routes, harbors, and service, but standard ranges and grades of material can be applied to any ordinary types and designs. The present paper will confine itself to the standardization of ship *materials,* referring to the type or design of ships only in so far as the standardization of their materials may be affected thereby.

3. It is impossible here, nor is the writer competent, to discuss in detail the multitude of different kinds of material that enter into the construction and equipment

of a ship, but some idea of their variety may be obtained from Appendices A and B, in which are given tentative classifications respectively of ship parts and of ship materials. Appendix C suggests a series of topics under which investigations into the standardization of such material might be conveniently grouped. While these three appendices should not be considered other than suggestive, they represent considerable investigation, and in addition to the information given they may afford a convenient series of pigeon-holes for the classification of additional data. Some standardization of miscellaneous parts has already been accomplished, as in the case of chain, anchors, lifeboats, hardware, and other parts, but it is believed the field offers opportunity for further work along the line of the plain materials and equipment used. Possibly such investigation might come within the scope of the American Society for Testing Materials. If there are present manufacturers of Engines, Pumps, or other Auxiliaries, they are invited to consider whether it should be necessary for the buyer of a ship, desirous of having her parts interchangeable, to restrict his purchases to the product of one maker.

4. While steel is only one of the many materials needed in shipbuilding, and while there are numerous steel products required in addition to those in the hull structure, yet the hull structure is so important, constituting as it does some 75 per cent of the weight and 50 per cent of the cost of a cargo ship, and its materials are of such special concern to the American Iron & Steel Institute, that the body of this paper will be devoted to that portion of the subject.

5. Let us first consider the opportunities for the standardization of hull steel as compared with other fields in which structural steel is used. While in some respects the requirements of a ship resemble those of rolling-stock, comparison with bridge building practice seems to offer the more practical appeal. A ship is a storm-tossed box-girder, a freight tank, a power-house, and a floating

hotel, all combined. The popular notion that her stresses are indeterminate is no more correct than in the case of fixed steel structures. The origin of design in both classes of structures was an accumulation of empirical rules, and in both cases theory has simply afforded an intelligent means of predicting the probable safety of an untried design from one whose behavior is known. The Titanic is matched by the Tay and the Quebec bridges.

The design of a ship indeed has some advantages over that of a bridge. When once built the bridge is largely left to the mercy of the elements (and of constantly increasing train loads), whereas on each voyage the captain of a ship has it within his power to stow and navigate in such a manner as to minimize the menace of the waves. It is of course true that this menace may reduce the safety factor of ignorance to a greater extent than in the case of a bridge.

The naval architect is also fortunate in that a large percentage of his loads are carried directly by the upward reactions due to buoyancy at different cross sections of the ship. Roughly speaking, the maximum longitudinal bending moment amidships is only about one-fourth the moment that would be caused by the uniformly distributed weight of ship and contents on a clear span equal to the ship's length; but this ratio does not hold at other points fore and aft.

If the inquisitive bridge engineer wishes to compare the accepted method of computing the principal stresses in a ship with his own theory of wheel loads, he has merely to lay off a trochoidal wave whose length equals that of the ship, and whose depth is one-twentieth thereof, and to correlate the severest possible conditions of loading with those of buoyancy under hogging or sagging (as calculated with the aid of Tchebycheff's Rule), when the maximum longitudinal bending moment at any point can be readily determined and compared with the section modulus there; but the process is tedious. The transverse and local strains are similarly subject to computa-

tion by the enterprising mathematician. The dynamic stresses are more elusive.

6. The Classification Societies, realizing that dangerous errors, due to inexperience, oversight, or (in rare cases) unscrupulousness, might accompany the preparation of stress diagrams for each design, have saved the purchaser and the shipbuilder the time and labor that such calculations would require by publishing tabulated rules giving the scantlings recommended for the various hull members in ships of the more usual types and dimensions. These rules are revised from time to time in line with experience based on the constant survey of both the construction and operation of ships. It is to be regretted, however, that the eight principal classification societies have not as yet agreed among themselves on a standard set of rules.

7. The authority of the better known societies is justly great, but emphasis should be laid on the fact that classification is not refused for variation from their rules provided the substitutions are equally efficient; and this privilege broadens the possibilities for standardizing ship materials. For example, practically nowhere in a ship do the members that constitute the framing consist merely of single rolled steel shapes, for while they may appear to do so it will be noted that one or both of their flanges unite with the heavy plating of the shell, deck, or double-bottom tank-top strakes, or of the bulkheads, to form compound members wherein the plating is generally the most active element, on much the same principle as that followed in ferro-concrete construction, where a part of the floor-slab is utilized as the compression flange of a Tee beam or girder. This arrangement permits of substitutions in the size and thickness of the elements in such compound members, for undesirable variations from the adopted standard range of shapes can frequently be avoided by modifying the plate thickness, and vice versa.

8a. On the other hand the possibilities for standardizing ship as compared with bridge material are limited

by several considerations. With a given fuel consumption, the earning capacity of ships of similar construction and equipment varies with the ratio between the weight of water displaced by the loaded ship and that of the ship when empty. Consequently any excess weight, added with a view of standardizing material, not only may increase the first cost, which is not the most important factor, but will certainly decrease her earning capacity during the entire life of the ship. The theoretical soundness of this argument, however, seems to have been greatly overworked, for it has been found that the material in a given design can be standardized without adding over one per cent (and usually very much less) to the total weight, and that a new design using standard material can in some cases be so arranged as to actually effect a saving in the quantity used.

8b. The essential requirement of water and oil-tightness also affects the determination of suitable material. In a bridge the main criterion is usually that of strength alone, but in a ship local stiffness against deflection is just as important in order to prevent leaks resulting from an opening up of the joints. Also, in order to assist tightness, in shipbuilding single rolled steel angles are preferred to the pair of angles so dear to the bridge builder, for the single angle is more readily caulked, and its use minimizes those opportunities for corrosion that are invited by the concealed pockets between the heels of a pair of angles. The need of watertightness also causes the ship designer to avoid 3-ply rivets (*i. e.,* rivets connecting three thicknesses of metal) as far as possible, for it is difficult to ensure the efficiency of such rivets, or to locate the source of a leak at such connections. Therefore 2-ply rivets are used wherever practicable, and this means that instead of concentrating a number of connections at one point or line, in shipbuilding the important joints are arranged to come off center, or staggered. The local stresses caused by this eccentricity are more than offset by its many advantages.

8c. Similar considerations explain in part the unsuitability for shipbuilding of standard structural channels less than 15 inches in depth, for their flanges are too narrow to receive the proper sized rivet hole, and their inner faces too steep to allow of a symmetrical rivet head, and the proximity of the rivet head to the fillet of the channel makes efficient laying-up very difficult. For this reason ship channels, having wide flanges with almost flat inner faces, are preferable for medium sized ship members, and bulb angles for the smaller ones. A bulb angle is stronger than a plain angle of equal weight; it can be readily manipulated on the bending slabs; and the mass of metal forming its bulb is a protection against the wear and tear of such cargoes as coal, ore, or steel. The bulb offers only a small surface to corrosion, and unlike the flange it is never in the way of riveting.

8d. While recognizing the advantage of Tees in facilitating the making of water and oil-tight connections, notably at the bulkheads of Isherwood tankers, as well as in the construction of bilge keels, the total demand for these sections as compared with the variety of contours offered by the few mills rolling them is insufficient to warrant their general use. Similar objections apply to the occasional specification of Zees. The popularity of "H" sections for use as pillars has been limited to a comparatively small number of yards, and the writer is not familiar with any difficulty in obtaining them, but the fact that the larger sizes are produced by only one mill, and the difficulty of making substitution in case of need, has made it desirable to generally refrain from their use, and this was apparently realized by the shipyards affiliated with the aforesaid mill. The symmetrical properties of the "I" beam, which is so popular in steel bridges, buildings, and cars, make this shape inefficient and wasteful in the compound members of which a ship's framing is necessarily composed, and it may be excluded from consideration for the purposes of this paper.

8e. A semi-medieval custom, whose effect is not al-

ways realized, has tended to befog the steel engineer in his efforts to clarify the application to ships of his experience in other structural lines, namely the terminology employed. This is due not so much to the use by shipbuilders of special terms (for who would rob the seafaring man of his picturesque phraseology?), but rather to the employment by both ship and bridge builders of common terms but with different meaning, and of different terms with the same meaning. Thus, the "deadweight" of a ship is the "live load" on a bridge. The structural engineer would call the "floors" of a ship "floor girders," while *his* "floors" are known in a shipyard as "decks." The "web-frames" of a ship correspond to bridge "portals," her "cant-frames" to "skew-portals," and her "bulkheads" to diaphragms." The "foundations" beneath a ship's machinery would be known on land rather as "grillage," while a marine "erection" is confined to "superstructure." The shipbuilder usually restricts the terms "gusset" plate and "stringer" to horizontal members, preferring the respective terms "bracket" and "girder" if they are vertical, and plain rolled steel "angles" are not classed as "shapes" in the older shipyards, whereas rolled steel "bars" are frequently so included. The "shell" of a ship might be termed "skin" by a structural engineer, who would "furnish" or "attach" members that in ship parlance are "fitted," and he would put a "crimp" in plates or frames that on the ways are "joggled." In those rare cases when bridge or building connections have to be made from field templates they are said to be "Manley'd" by our biggest fabricator, whereas on a hull they are "lifted" from the frames.

9. In spite of these unknown tongues, it will be evident that the material used is the distinguishing factor in the differing conditions of design. In a ship the plates (which make up some two-thirds of her tank-like hull structure) are the all-important element, the shapes serving merely to brace and locally reinforce the plating;

whereas in a bridge or building the shapes preponderate as the nucleus of its skeleton framework, plates being used in large measure merely to unite and reinforce the shapes.

10. Some old line shipbuilders have argued that the cost of the plain material in a ship is a comparatively small percentage of the finished hull, and that the need for standardizing ship materials is therefore not so urgent. Such an argument overlooks the most vital aim of standardization, which is to increase production by simplifying all the processes involved—at the rolling mill, in the shop, and on the ways—although as regards material cost alone it is reasonable to believe that in the long run better terms, as well as service, may be procurable from the rolling mills for a tonnage that is attractive from the standpoint of mill operation, as opposed to one requiring too frequent roll changes or other irksome features.

11a. That such standardization was necessary in order to successfully carry out the enlarged shipbuilding program which formed perhaps the keystone of this country's contribution to the War, and which is expected to continue on a scale undreamed of a few years ago, is evident from the following facts. Rolled steel plates were being ordered in at least three different and non-interchangeable ways, some specifications giving weights per square foot, some giving thicknesses in sixteenths, thirty-seconds or sixty-fourths of an inch, and some using the decimal system varying by even hundredths of an inch, the latter having partially replaced the old British use of twentieths of an inch. To further complicate matters our mills were simultaneously executing foreign orders based on the metric system. It frequently happened that the quantity required of some odd thickness was totally insufficient to warrant changing the rolls. While it is manifest that such variations are closer than it is feasible to produce on a commercial basis, and closer even than the rolling mill tolerances permitted by the

specifications, and while in many cases substitutions were, as a matter of fact, allowed after receipt of specifications by the mills, yet the confusion resulting from this meticulous attempt on paper to secure unnecessarily minute variations, especially when the tonnage was to be allocated through the War Industries Board, made it imperative that a simple and uniform range of thicknesses be adopted.

11b. Additional confusion and delay were being caused by the use of differing order forms and quality specifications, by the slowing down of the mills to shear to sketch awkward and irregular shaped web-plates, brackets and gussets (which usually had to be re-trimmed at the shipyard), and by the excessive quantity of hieroglyphic location marks that the mills were expected to paint on each plate, and which at times required more space than the surface of the smaller plates afforded.

11c. While the tonnage of rolled steel shapes required is only about one-half that of plates, the diversity of sections (see Appendix D) that were being specified by the seventy odd steel shipyards in this country, even when their ships were to the same design (see Appendix E), aggravated by the absence of uniformity between the steel makers in the contours of many of their sections, made the question of standard shapes equally important and much more of a task. The number of different shapes used reached the astounding total of 131, and the number of their different thicknesses 403, even when those thicknesses of the same shape that did not differ by more than 2½ per cent were counted as the same section. In one hull, involving about 500 tons of shapes, there were 42 different sections and 118 distinct thicknesses, of which 9 sections were rolled only at one mill and one tee section at another mill. Of separate sections there were items as low as 8 lbs. per hull, and 35 thicknesses involved less than 500 lbs. each. Of one shape only 43 lbs. per hull were required. While many of these sections were for use in secondary members, their specifica-

tion seriously hampered the mill in cleaning up orders.

11d. A comparatively small tonnage of rolled steel bars (other than rivet rods) is needed for each hull, mainly for use as liners or fillers, but here again minute variations in thickness and width, often required only to give a neater appearance, caused unwarranted difficulty in the complete shipment of the mill orders for any portion of a hull.

12. These were the factors responsible for the so-called "lag-lists." These were the odds and ends that threatened to render unavailing the strenuous efforts of the rolling mills to ship in sequence, and that encouraged an otherwise unnecessary "cushion" of reserve stock at one time aggregating over a million tons. These were the conditions that made it possible for one of our large shipyards to have received some 30,000 tons of steel without having on hand enough of the proper sizes to allow them to proceed with the construction of a single ship. The responsibility for these conditions was as usual divided, and need not be reviewed at this time. The important thing was to remedy the situation, and here again the credit should be divided, for it was only by the hearty co-operation of the Emergency Fleet Corporation, the steel makers, the fabricating shops, and the shipyards that a practical form of standardization was achieved.

13. Before narrating the steps taken in this country for such standardization, it should be stated that contemporary but independent action, with similar aim, was maturing in the British Isles, where the Admiralty, the steelmakers and the shipbuilders also realized the interference with ship production that resulted from a multiplicity of different sized material. Accordingly in December, 1917, a list of standard sections was drawn up and published under the joint auspices of the Admiralty and the Minister of Munitions, by the use of which regular and frequent rollings might be facilitated, and delays avoided. For cargo ships this list selected four sections of plain angles, three of bulb angles, and two of ship

channels, making a total of only nine sections in all. It should be noted, however, that as a result of the practice of the British mills to roll with much closer variations in thickness than we do, these nine sections gave the designer about as much latitude on paper as twenty-seven of ours.

14a. Although the opportunity to standardize the steel shapes used in shipbuilding in the United States did not fully materialize until after the British had acted, yet we beat them to it as regards plates. In July, 1917, representatives of our steel plate mills met in Washington and adopted an outline of recommended standard practice sponsored by Mr. R. B. Woodworth, Engineer with Carnegie Steel Co., and this was subsequently adopted by the Emergency Fleet Corporation as a guide to the shipbuilders in placing orders with the mills for ship steel. This recommended standard practice received such wide publicity in the pamphlet entitled "Structural Steel for Ships," that only its more salient features need be summarized here:—

Plates to be ordered to fractional thickness in multiples of 1/16 inch or to a table of weights corresponding approximately thereto, multiples of 1/32 inch being allowed in special cases.
Sketch plates to be sheared at the shipyards.
Universal mill plates to be used wherever possible.
Multiple lengths and widths to be allowed as far as practicable.
Extreme sizes to be avoided.
Specification of definite and uniform grades of steel.
Elimination of location marks on material as shipped from the mills.

The first edition of the above mentioned pamphlet also limited the list of plain angles recommended, and urged that orders for other shapes be confined to American standard "I" beam and structural channel sections, although it allowed the use of ship channels and bulb angles in special cases. While it was recognized that ship

channels and bulb angles were most suitable for shipbuilding, yet at that time the limited facilities in this country for their manufacture made it desirable to encourage the use of only such structural shapes as could be allocated to any steel maker. A complete selected list of structural sections seemed unnecessary in view of the Emergency Fleet Corporation's plan for the standardization of design.

14b. These standardized designs, however, failed to reduce the variety of sizes, especially in the so-called "fabricated" ships where it seemed as if bridge had been added to ship sections by the inability of the two classes of draftsmen to combine, and an excessive multiplicity of sections was the result. Also many yards continued to specify ship channels in such quantity that several steel makers who had not previously rolled them were arranging to produce these shapes, as well as bulb angles.

14c. Uniformity could be secured only by standardizing the range of sections to be rolled, and by the adoption of a selected list of sections to be specified. But who should say just which sections should be included in such a standard range and list? If predicated merely on the opinion of one investigator his judgment might well be challenged. It was evident that these standards, in order to carry weight, must be based on a survey, both broad and detailed, of the entire practice of all the shipbuilders in the country, and that the results must then be correlated with the productive capacity of all our rolling mills, modified where necessary to suit the most prevalent and warranted requirements of design and construction.

In August, 1918, such a survey was undertaken by the writer, who had been placed in charge of the Standardization of Ship Steel under Dr. H. C. Sadler, Naval Architect, by Mr. Daniel H. Cox, Manager of the Division of Steel Ship Construction, Emergency Fleet Corporation.

The starting point was the compilation and analysis of 84 classified summaries showing the quantity of each thickness of every section used in each of the 44 designs

to which the 1,508 ships canvassed were being built. As these ships had a total deadweight capacity of 10,302,150 tons, and involved 1,100,651 tons of steel shapes, their analyses might be considered representative. Most of the summaries were furnished by the 60 shipyards reporting, supplemented by compilations and weight extensions made from steel schedules and designs on hand at the home office of the Emergency Fleet Corporation. Sets of 52 large charts were prepared from these summaries, showing graphically the relative popularity of each section, and these were of value, not only as a basis for the recapitulations included in the formal report, but also, as the work progressed, to indicate the probable sections to be recommended, for simultaneously with the preparation of the data informal conferences were held with representatives of most of the rolling mills and of many fabricating shops and shipyards, who were thereby enabled to save time when later called upon for definite action. A total of over a quarter of a million figures were tabulated or otherwise handled, the time required for the preparation and issuance of the report being two months and one week, which was one week longer than promised on account of delay in securing data from a few of the nearby shipyards.

14d. On October 15, 1918, a report was submitted to the officials of the Emergency Fleet Corporation, in which the above outlined need of further standardization was supported by tabulated statistics, and a selected list of sections proposed, together with the recommendation that copies of the report be placed in the hands of all the interested steel makers and shipbuilders with a request for constructive comment and criticism. It was further recommended that, with the allowance of suitable time for the receipt and digestion of such comment and criticism, the steel makers represented by the American Iron & Steel Institute be invited to a conference in Philadelphia, there to confer among themselves and with representatives of the Emergency Fleet Corporation

with the view of modifying their rolls so as to produce like sections, and of publishing selected ranges of contours and weights thereof. Certain other detailed revision of the previously recommended standard practice was suggested with the view of making more uniform and efficient the methods of ordering ship steel, and it was finally recommended that the findings of this conference, upon approval, be made effective by the issuance of a formal order to the shipyards by the Emergency Fleet Corporation. No steel maker was asked to scrap any rolls or to prepare any new ones, as it was recognized that this was his own affair, but it was urged that a common standard be agreed upon with which such sections as each maker produced or contemplated should comply.

14e. Conformably with the invitation extended in accordance with this report, conferences were held at the offices of the Midvale Steel Corporation, Philadelphia,, on November 19 and 20, 1918, which were attended by representatives of all the larger mills rolling structural steel shapes, namely, Bethlehem Steel Company, Cambria Steel Company, Carnegie Steel Company, Eastern Steel Company, Illinois Steel Company, Inland Steel Company, Jones & Laughlin Steel Company, Lackawanna Steel Company, Phoenix Iron Company, and Tennessee Coal, Iron & Railroad Company. The Vice Chairman of the Sub-Committee on Steel Distribution of the American Iron & Steel Institute, who had heartily co-operated in the proposed plan of standardization, was also represented, together with the Chief Designer of the Emergency Fleet Corporation, and the writer. Communications had meanwhile been received from other shape mills, as well as from a large number of the shipyards, advising their approval of the movement and submitting in detail many valuable suggestions.

The first day was occupied by the steel makers in technical discussion of the modifications necessary to standardize their shape rolls, and of the proposed selected list of sections. In order to secure uniformity of action

it was agreed that the detailed properties of the New American Standard Sections should be calculated by the Carnegie Steel Company and checked by the Cambria Steel Co. On the second day the findings of this conference, as regards the recommended standard practice, were submitted to the representatives of the Emergency Fleet Corporation, who with a few minor modifications acceptable to the steel makers, approved them. The subsequent issuance by the Emergency Fleet Corporation of a second edition of the pamphlet entitled "Structural Steel for Ships," in which the revised recommended standard practice was adopted, the formal endorsement of the findings of the conference by the Association of American Steel Manufacturers, on February 21, 1919, and the general distribution by the steel makers of publications covering their new standard products, make it unnecessary to reprint the recommendations in this paper. It should be stated, however, that the variety of different shapes was reduced from 131 to 27, and of different thicknesses of sections from 403 to 115, and that the New American Standard Sections of ship channels and bulb angles were based on the British Standard Sections.

14f. In view of the fact that some misconception has existed regarding these New American Standard Sections a word of explanation seems to be in place. Prior to the action just narrated, the United States had no standards for the shapes in question—the shipbuilding demand had not warranted it. Instead there was a heterogeneous growth of sections whose profiles and weights differed with each mill, for which in many cases rolls had been turned up in periods of business depression to meet the desires of the various shipyards for something a little lighter than competitors were using. These sections were often too slender for economical manufacture, and offered no basis for standardization.

In the British Isles, however, where steel shipbuilding had its cradle, and, until recently, its greatest develop-

ment, the demand for suitable and uniform sections had made necessary the adoption of a series of standards. To this end, in 1904, an Engineering Standards Committee was appointed under the auspices of the British Institutions of Civil, Mechanical, and Electrical Engineers and of Naval Architects, as well as of the British Iron & Steel Institute, and this committee, after the most careful investigation, recommended for use in all these fields of engineering construction a series of standard sections that were acceptable to both makers and users, including the shipbuilding industry. These were called the British Standard Sections, and these are the sections on which are based the British bridge, building, and rolling-stock specifications, and the tabulated rules of the British ship classification societies, as well as those of our own American Bureau of Shipping. These rules and specifications we had not hitherto been able to satisfy except by frequent substitutions that involved a sacrifice of material and annoying changes in templates. The standards now forming a part of the recommended practice of American steel makers will, as far as they go, enable us to comply with the shipbuilding rules, and also more efficiently to take care of the export demand for rolled shapes regardless of their purpose. They are better adapted to economical manufacture than are our structural channels or the motley crowd of sections replaced. They should make for international comity by reducing to common terms the language of negotiation, even though it be combined with more effective competition.

To clearly understand the situation, however, it is important to remember that the practice of the British rolling mills differs from ours in that they roll to any thickness desired (usually by nominal steps of even hundredths of an inch), whereas we find it more profitable for the maker, and ultimately more serviceable to the user, to adopt a series of specific weights per lineal foot intermediate between the maximum and minimum. Conforming to foreign custom the tables of British Standard

Sections publish only one standard thickness for each of the sizes of shapes in question, namely, the thickness at which the web and flange of the section are exactly the nominal dimensions of the shape, with an explanation that for other thicknesses these dimensions will vary with the desired squeezing or spreading of the rolls.

In order to secure the benefit of the British standards, and at the same time comply with the valuable practice of our United States mills, the New American Standards start out with the adoption of the British standard thickness of the section in question, and to this the rolls are cut. We then list one thickness five one-hundredths of an inch below, together with upper thicknesses generally varying in the ship channels by one-tenth of an inch, and in the bulb angles by five one-hundredths of an inch. These ranges take care of the lower thicknesses even more consistently than the tabulated rules of the classification societies, and they also cover all the upper thicknesses specified in the rules that seemed warranted by demand. It is believed that a scrutiny of these details will show the basis of the New American Standard Sections to have been warranted.

14g. Incidentally it should be remarked that several of these ship sections are popular also among manufacturers of rolling-stock in this country, and the suggestion is made that such manufacturers familiarize themselves with the changes adopted in the new standards. The modifications will not be inconvenient.

15a. It is a little early to speak of the full results of these steps toward standardization. Their primary purpose was to help win the War by assisting in the speeding up of the production, fabrication, and assembly of ship steel. And then came the unexpected armistice, which made less imperative the military features that had been aimed at. But any feeling of disappointment that these aims had been only partially realized at that time was more than compensated by relief at the saving of further blood-shed and devastation. Moreover, all the details

had been handled with an eye to future conditions of peace as well as those of the recent emergency. It is gratifying, however, to note that early in 1918 the industry was already benefiting from the degree of standardization then accomplished. As a result of the uniformity of specifications received, one of our newer plate mills, with a normal capacity of 12,500 tons per month, was enabled to increase its product to 16,000, 17,240, 18,025, 19,145, and even 20,973 tons per month.

15b. As regards shapes, the shipbuilders are substituting the standard sections now recommended as rapidly as the progress of their work will permit, and it has been possible by the elimination of odd sizes to design a 9400 ton ship with only 16 different shapes and 44 thicknesses of section, as opposed to the former averages of 28 shapes and 73 thicknesses per ship, and this was evidently accomplished without increase in weight of steel, for the builder asked no increase over the agreed price for the ships. In general it has been found that yards using the least variety of different sections show the greatest efficiency in the delivery of ships, while the performance of yards using a great variety is the least satisfactory in proportion to their total tonnage. As regards the shape mills, it is understood that, after cleaning up their partially filled orders, as soon as a set of rolls require redressing the grooves are being modified to suit the new standards for ship channels and bulb angles, some rolls being scrapped and some new ones prepared as a matter of operating convenience.

16. All of the efforts toward standardization were made from the broad standpoint of benefit to the whole country. Encouragement and co-operation were extended by the Government agencies, and by former competitors and associates alike, from the Chairman of the Committee on Steel Distribution of the American Iron & Steel Institute, and the high officials of many of the large shipbuilding companies, to the draftsmen in the yards and the order clerks at the mills. It is hoped and believed

that the steps taken will continue to assist the entire industry as long as the recommendations are consistently carried out, or until they are superseded by something better.

## APPENDIX A.

### Tentative Classification of Steel Ship Parts.

Hull-Structure. Hull-Engineering.
Hull-Accessories. Propulsion.

*Hull-Structure*—

Main (primarily for hull strength).
Foundations and Local Reinforcement.
Secondary (not for hull strength, nor movable, nor machinery).

*Hull-Accessories*—

Fittings (non-structural metal, attached to hull).
Carpenter (rough woodwork, including Hardware, forming permanent part of ship).
Joiner (finished woodwork, including Hardware and Glazing, forming permanent part of ship).
Coatings (attached to surfaces of hull structure, except insulation).
Equipment (for operation, but not propulsion, of ship, not attached to hull).
Furnishings (for welfare of ship's company, not permanently attached to hull).

*Hull-Engineering*—

(machinery other than that needed for propulsion).

Auxiliaries.
Communication.
Heating.
Refrigeration.
Plumbing (Fixtures).
Piping.

*Propulsion*—
(machinery needed to propel the ship).
Steam Production.
Main Machinery.
Auxiliaries. . .
Piping.

## Detailed Classification.

### Hull Structure.

*MAIN*

*Keels*—
(with Doublers and Buttstraps).
Flat
Bar
Bilge

*Keelsons*—
(with Long'l. Angles and Clips).
Main
Side.

*Shell Plating* (flat, or bent hot or cold)
(with Doublers and Buttstraps).
Garboard.
Bottom.
Bilge.
Side.
Sheer.
Counter.

*Floors* (with Brkts., Gussets and Clips)—
(i.e. Transverse Girders in Double Bottom).
Tight (incl. Fndn. Reinforcement, Sumps and Coffer-dams).
Lightened.
Skeleton.
Deep.
Bilge Brackets.

*Intercostals*—
- Double Bottom (incl. Fndn. Reinforcement, Sumps and Cofferdams).

*Tank Top Plating*—
- (with Doublers and Buttstraps).
- Rider Plates.
- Inner Bottom.
- Margin Plates.

*Bulkheads* (with Hor. and Vert. Stiffeners, and Brkts.)—
- (for Hull Strength: Others listed under "Secondary").
- Collision.
- Hold.
- Eng. & Fire Room.
- After Peak (Stuffing Box).
- Longitudinal.

*Frames* (with Brkts. and Clips)—
- (Single, Reverse, Deep, Web: Plain, or Bent, hot or cold).
- Transverse—
  - Side.
  - Deck.
  - Hatch-end Beams.
  - Half Beams.
  - Strong Beams—
    - Hold.
    - Machinery Space.
  - Panting Beams.
  - Hoist Beams
- Longitudinal.
- Cant.

*Stringers* (horizontal)—
- (with Brackets, Clips and Angle Bars).
- Side.
- Panting.
- Breast Hooks and Crutches.
- Deck.

*Expansion Trunks*—

*Shaft Alley*—

(with Stiffeners).

Main.

Thrust Recess.

Stuffing Box Recess.

*Pillars and Stanchions*—

(with Connections).

*Girders* (vertical)—

Deck Pillar.

Cargo Hatches.

Eng. & Boiler Hatches.

Coal Hatches.

Other Deck Openings.

*Deck Plating*—

(with Stringers, Doublers, and Buttstraps).

Main.

Upper.

Shelter.

Bridge.

Poop.

Forecastle.

Flats (or list under "Secondary").

*Stern Frame* (with Conns.)—

(Forged Iron or Steel, or Cast Steel).

*Stem*—

Upper (Rolled and Bent).

Lower, or Fore-foot (Rolled and Bent, or Cast Steel).

*Liners*—

(Flat or Tapered. Stop Waters listed under "Coatings").

*Rivets*—
- Heads—
  - Pan.
  - Snap.
  - Countersunk.
- Points—
  - Hammered (Cone).
  - Snap.
  - Countersunk.
- Shanks—
  - Plain.
  - Swelled Neck.
  - Tap.

### *FOUNDATIONS AND LOCAL REINFORCEMENT FOR FITTINGS AND AUXILIARIES.*

*Foundations*—
- Boiler Saddles.
- Engine and Condenser.
- Thrust Bearing.
- Shaft Stools.

*Local Reinforcement*—
- Frames of Angles or other Shapes.
- Doubler Plates.
- Stanchions—
  - Fixed.
  - Movable.

### *SECONDARY*

Engine and Boiler Casings (except Coamings).
Screen Bulkheads (Spectacle, between Eng. and Boil. Rooms).
End Bulkheads for Poop, Bridge, and Forecastle.
Deck Houses.
Other Minor Bulkheads.
Coal Bunkers and Trunks.
Bulwarks and Braces.
Tanks (other than Double Bottom).
Mezzanine Flats (over Eng. Room).

Swash Plates.
Chain Lockers.
Magazine and Ammunition Trunks.
Vent, Light, and Access Trunks.
Companion Hatches.
Skylight Framing.
Pipe Casings.
Boat Scaffolds (if metal).
Cargo Battens (if steel).
Moulding and Chafing Irons.
Gun Platforms. . .

*Note.* Floor Framing and Checkered Floor Plating, Gratings and Railings for Eng. and Fire Rooms listed under "Propulsion."

### Hull Accessories

#### *FITTINGS*

*Access*—

Steel Doors and Ports (Sliding W .T. Doors listed under "Hull Engineering").
Wire Mesh Doors and Gates.
Hatch Covers (metal work).
Manholes, Covers, Scuttles and Freeing Ports.
Sidelights.
Fixed Ladders and Companion Ways.
Stack Lookouts, fore and aft.
Gratings (but not in Eng. and Fire Room)—
 Plain.
 Patent. . .

*Handling Cargo*—

Derrick Steps and Partners.
Masts—
 Cargo only.
 Ventilator.
Booms.
Cleats, Eyeplates, and Ringbolts.

*Davits*—
Lifeboat.
Anchor.
Ladder.

*Rudder* (Plate, Cast, or Fabricated)—
Stock (Upper and Lower).
Arms.
Plate.
Filling.

*Handling Ship*—
Hawse and Chain Pipes .
Hawse Flaps.
Bitts, Chocks, Fairleads, and Mooring Pipes.
Lugs for Propeller Tackle.

*Ventilation*—
Airports and Ducts
Ventilators (see also Masts, above).
Skylight Gear.

*Other Fittings*—
Railings (if metal, incl. Brass Rail around Compass)—
Awning Supports.
Fire Plugs.
Scuppers and Drains.
Metal Name and Draft Figures.
Lockers (if metal, and built-in).

*CARPENTER WORK*

Caulked Decks.
Railings and Fenders.
Hatch Covers (woodwork).
Bed pieces and Packing.
Cargo Battens (if wood).
Ceiling in Bilges and Holds.
Pipe Casings.
Skids and Brows.
Boat Chocks, Ridgepoles, and Strongbacks.
Chests for Deck Gear.

Hawse Bucklers.
Boom Crutches.
Racks and Stowage for Life Preservers and Buoys.
Racks for Fire Hose.
Leadman's Platform.
Hardware.

*JOINER WORK*

Joiner Decks and Floors.
Bridge and Weather Rails.
Wood Houses.
Ceiling—
    Overhead and Beam Capping (under exposed decks).
    Side and Airport Trim.
Joiner Bulkheads and Partitions.
Wood Doors (and Screens)—
    Outside and Inside.
Windows (and Screens).
Boxes, Board and Screens for Side and Running Lights.
Stairways, Stairs, and Wood Ladders.
Wood Grab Rails.
Wood Skylights and Vent Trunks.
Inside Finish for all Rooms (List?).
Fixed Furnishings—
    Bath, Toilet and Wash Rooms.
    Saloon and Mess Rooms.
    Hospital.
    Galley and Pantries.
    Cold Storage Room.
    Storerooms.
Shelving.
Wood Gratings.
Hardware.
Glazing.

*COATINGS*

Cementing.
Bituminous Coatings.
Stop Waters.
Painting Hull.

Painting and Finish Joiner Work.
Tiling, Linoleum, and Floor Composition.
Name, Draft Figures, and Marking.

*EQUIPMENT*

*Tackle* (with Fittings)—
- Inboard—
  - Cargo (Stays and Running).
  - Boat and Raft (Guys and Running).
  - Stack Guys.
  - Flag (Running).
  - Comp. Ladder (Running).
  - Anchor (Running).
  - Blocks.
- Outboard—
  - Anchors.
  - Chains (incl. Spares).
  - Cables.
  - Hawsers.
  - Warps.
  - Leadman's Gear.

*Life Saving*—
- Boats, Rafts, with Equipment.
- Preservers.
- Buoys (complete).
- Fire Hose.
- Rockets (or equivalent) with Lines Complete.

*Fire Protection* (see also "Hull Engineering—Int. Communication and Piping")—
- Buckets and Axes.
- Hose and Reels.
- Extinguishers.

*Storm Oil*—

*Nautical Outfit*—
- Compass and Binnacle.
- Chronometer and Clocks.
- Lead Lines.

Log, with Book and Slate.
Barometer.
Drawing Instruments.
Flags and Signals.
Signal and Search Lights.
Submarine Sounding Machine.
Ship's Bells.
Fog Horn and Whistle.

*Portable Fenders*—

*Canvas Work*—

Awnings.
Tarpaulins.
Other Covers (except Hull Surface Coatings).

*Accommodations and Ladders* (if portable)—

### *FURNISHINGS*

*Furniture*—

Wood—

Tables and Decks.
Chairs, Stools and Benches.
Lockers and Medicine Chests.
Berths.
Dressers and Mirrors.
Towel and Toilet Racks.

Metal—

Berths and Spring Mattresses.
Lockers and Safes (if movable).

Dry Goods—

Carpets, Rugs and Upholstery.
Curtains and Shades.
Mattresses and Pillows.
Napery—

Sheets and Pillow Cases.
Table Cloths and Napkins.
Towels.

Blankets and Counterpanes.

Outfits—
- Deck.
- Carpenter.
- Lamp.
- Paint and Oil.
- Galley Range with Outfit.
- Pantry and Galley.
- Mess.
- Amusement.

Consumable Stores—
- Steward's Deck Allowance.

## Hull Engineering

### *AUXILIARIES*

*Handling*—
- Ship—
  - (Rudder listed under "Hull-Fittings").
  - Windlass (with Chain Stopper).
  - Capstan (or Warp Winches).
  - Steering Engine (with Gear and Details).
- Cargo—
  - Hoisting Engines (Winches)—
    - Nigger Heads.
    - Extended Shafts.
  - Cargo Oil Pumps.
- Water—
  - Salt—
    - Fire and Bilge Pumps.
    - Ballast Pumps.
    - Sanitary Pumps.
  - Fresh—
    - Fresh Water Pumps.
- Ashes—
  - Ash Handling Gear (complete).

*Electric*—
- Generator (with Engine).
- Storage Battery.

Switchboards.
Wiring (with Conduits).
Lighting Fixtures (incl. Arc.).
Instruments.
Motors.
Fans.

*COMMUNICATION*

*External*—
Wireless Outfit.
(other parts listed under ''Hull-Equipment'').

*Internal*—
Fire Alarm.
Directing Indicator.
Telegraphs.
Telephones.
Voice Tubes.

*Heating*—
Radiators.

*Refrigeration Machinery.*

*Plumbing Fixtures.*

*Spares.*

*Tools.*

*Pipe and Fittings* (with Traps, Valves and Manifolds, and Insulated Covering)—
Steam.
Water—
Salt.
Fresh.
Oil—
Fuel.
Cargo.
Lubricating.
Air.

## Propulsion

### *STEAM PRODUCTION*

*Main Boilers* (Scotch Marine)—

- Shell (with Doublers and Connections).
- Flanged Heads.
- Girders.
- Combustion Chamber.
- Furnaces.
- Tubes and Flues (with Ferrules).
- Retarders.
- Stays (with Washers and Nuts).
- Braces.
- Crown Bars.
- Rivets.

- Fittings—
  - Internal—
    - Dry Pipe.
    - Feed Pipes.
    - Other Pipes to Valves.
    - Hydrokineters.
    - Circulators.
    - Fusible Plugs.
  - External—
    - Manholes (with Covers).
    - Valves—
      - Safety.
      - Stop.
      - Check.
    - Blows—
      - Surface.
      - Bottom.
    - Salinometer Cocks.
  - Furnace—
    - Coal—
      - Fronts.
      - Bridge Walls.

Bearing Bars.
Grates.
Fire Brick and Clay.
Oil—
Fronts.
Nozzles and Burners.
Air Registers.
Fire Brick and Clay.
Superheaters.
Mech. Stokers.
Fastenings.
Draft (Fans listed under "Hull Eng.-Electric")—
Ducts.

*Donkey Boilers* (complete).

*Uptakes.*

*Stacks* (with Air Casings and Capes).

*Lagging and Covering* (excl. Pipes).
(Ash Handling Gear listed under "Hull-Engineering").

*MAIN MACHINERY*

*Main Engines*—
Stationary—
Bed Plate and Main Bearings.
Columns and Crosshead Guides.
Cylinders with Liner and Covers.
Valve Chest with Liners and Covers.
Steam Receivers.
Drains.
Stuffing Boxes.
Cylinder Lagging and Covering.
Moving—
Valves with Stems and Gear.
Pistons with Rods.
Crosshead.
Connecting Rod.
Crank Shaft.
Eccentrics with Rods and Straps.

Links with Blocks (incl. Suspension).
Rocker Shaft and Arms.
Attached—
Reversing Engine and Gear.
Turning Gear.
Handling Gear.
Indicator Gear.
Levers and Links for Attached Pumps.
Throttle Valve and Gear.

*Oil Engines*—
Main Units.
Electric Sets.

*Main Turbines*—
Cylinder and Rotor.
Transmission—
Reducing Gear.
Electric.
Attached.
Reversing.

*Main Condenser.*

*Lifting Gear.*

*Shafting* (with Flanges, Bolts, and Composition Sleeves)—
Thrust.
Line.
Tail—
Nut.

*Shaft Bearing*—
Thrust—
Horseshoe.
Kingsbury.
Steady.
Stern Tube.

*Bearing Metal.*

*Lubrication*—
Cups.

Propeller—
    Solid.
    Detachable Blade.

*AUXILIARIES*

*Aux. Condenser.*

*Tanks*—
    Feed.
    Filter.
    Inspection.
    Oil.
    Waste Lockers.

*Oil Filter.*

*Feed Water Heater.*

*Fuel Oil Heater.*

*Evaporator.*

*Distiller.*

*Pumps*—
    Fuel Oil Transfer.
    Fuel Oil Service.
    Main Feed.
    Aux. Feed.
    Evaporator Feed.
    Main Circulating (with Engine).
    Main Air.
    Combined Air and Circulating.
    Lubricating Oil.
    Oil Cooler.

*Injectors* (or list under "Boilers").

*Sea Connections.*

*Overboard Connections.*

*Eng. and Boiler Room Structural*—
    Framing.
    Checkered Floor Plates.

Gratings.
Handrails.
Guards and Pans.

*Workshop and Storeroom*—

Fire Room Spares .
Fire Room Tools.
Eng. Room Spares.
Eng. Room Tools.
Aux. Spares.
Consumable Stores.

*Pipe and Fittings* (with Traps, Valves and Manifolds, and Insulated Covering)—

Steam.

Water—
  Salt.
  Fresh.

Oil—
  Fuel.
  Cargo.
  Lubricating.

Air.

## APPENDIX B

### Tentative Classification of Materials

*MAIN HEADINGS*

*Steel Rolling Mill Products*—

Semi-finished.
Plates.
Shapes.
Bars.
Bands.
Hoops.
Sheets.

*Tubular Steel Products*—
- Pipe.
- Tubes.
- Fittings.

*Steel Wire Products*—
- Rods.
- Shafting.
- Wire.
- Wire Rope.
- Springs.
- Miscellaneous.

*Steel War Products.*

*Cast Steel Products.*

*Cast Iron Products.*

*Forged Steel (or Iron) Products.*

*Raw Ferrous Materials and By-Products*—
- Ore.
- Pig.
- Cement.
- Slag.
- Coal.
- Tar.
- Coal Gas.

*Fabricated Steel Products.*

*Non-Ferrous Metallic Products*—
- Lead.
- Tin.
- Antimony.
- Quicksilver.
- Zinc.
- Silver.
- Copper.
- Alloys.

*Non-Metallic Products*—
- Quarried.
- Oils.
- Ligneous.
- Refractory.
- Glass.
- Ceramic.
- Fibrous.

## Detailed Classification

### *STEEL ROLLING MILL PRODUCTS*

*Semi-finished*—
- Blooms
- Billets.
- Slabs.
- Rods.

*Plates*—
- Sheared—
  - Wide or Narrow.
  - Rectangular, Taper, or Sketch.
- Universal—
  - Sheared Ends.
  - Cold Sawed Ends.
- Checkered.
- Skelp.
- Grades—
  - Hull—
    - Ordinary.
    - Flanging—
      - Hot.
      - Cold.
    - High Tensile.
  - Tank—
    - Ordinary.
    - Soft (for bending).
  - Boiler—
    - U. S. Steamboat Inspn.—
      - Shell.
      - Furnace.

Flange.
Tank.

*Shapes*—
- Channels—
  - Ship.
  - Structural.
- Angles—
  - Plain—
    - Structural Sizes.
    - Bar Sizes.
  - Bulb.
- Tees—
  - Plain.
  - Bulb (Bulb Beams).
- Bulb Bars.
- "I" Beams—
  - Standard.
  - Thin Web.
  - Wide Flange.
- "H" Beams—
  - 8 inch and under.
  - Over 8 inch.
- Zees—
  - Standard.
  - Hatch Section (Tyzack).
- Sash.
- Grades (same as Hull & Tank Plates).

*Bars*—
- Square—
  - Plain.
  - Twisted.
- Round.
- Half-round—
  - Solid.
  - Hollow.
- Flat—
  - Square Edge.

Oval Edge.
Strip.
Deformed.
Grades—
Rivet—
Hull.
Boiler.
Stay—
Longitudinal.
Combustion.
Chain.
Cutlery.
Alloy.
Others (same as Plates).

*Bands*—
Finish—
Black.
Galvanized.

*Hoops*—
Finish—
Black.
Galvanized .

*Sheets*—
Grades—
Ordinary.
Special.
Alloy.
Finish—
Black.
Galvanized.
Tinned.

## *TUBULAR STEEL PRODUCTS*

*Pipe*—
Structural—
Pillars and Stanchions.
Davits.

- Masts and Booms.
- Ventilators.
- Scuppers.
- Railing.
- Awning Supports.
- Skylight Gear.
- Berths.
- Finish—
  - Black.
  - Galvanized.
  - Sherrardized.

Internal Pressure—
- Air.
- Steam.
- Water—
  - Salt.
  - Fresh.
- Oil—
  - Fuel.
  - Cargo.
  - Lubricating.
  - Glycerine.
- Ammonia.
- Gases.
- Grades—
  - Lapweld.
  - Buttweld.
- Finish—
  - Black.
  - Galvanized.

*Tubes*—

Internal Pressure—
- Water Tube Boiler.

External Pressure—
- Fire Tube Boiler.
- Stay.
- Flue.

Grades—
Seamless.
Lapweld.

*Fittings*—
Joint.
Valve.
Grades.
Finish—
Black.
Galvanized.
Sherrardized.

*STEEL WIRE PRODUCTS*

*Rods*—
Hot Rolled (for further manufacture).

*Shafting* (small sizes)—
Cold Drawn and Cold Rolled.

*Wire*—
Shape—
Round.
Flat.
Grades—
Basic O. H.
Bessemer.
Finish—
Bright.
Galvanized.
Tinned.

*Wire Rope*—
Outboard—
Towing Hawsers.
Mooring Lines.
Inboard—
Rigging.
Hoisting.
Fittings—
Hooks.

Sockets.
Shackles
Turnbuckles.
Blocks.
Finish—
Bright.
Galvanized.
Fiber-clad.

*Springs*—
Extension.
Compression.
Torsion.

*Wire Screens.*

*Nails.*

*Spikes.*

### *STEEL WAR PRODUCTS*

*Plates*—
Armor.
Protective Deck.

*Guns.*

### *CAST STEEL PRODUCTS*

*Lower Stem* (Forefoot)—

*Stern Frame*—

*Rudder*—
Solid, or Stock and Arms.

*Anchors*—

*Stud Chain* (Electric Steel)—

*Machinery Parts*—

*Finish*—

### *CAST IRON PRODUCTS*

*Propeller*—

*Stern Tube*—

*Hull Fittings and Furnishings*—

*Machinery Parts*—

*Finish*—

*Stem—*

*Stern Frame—*
(or Iron).

*Rudder—*
Stock (or Iron).
Arms (or Iron).

*Anchors—*

*Line Shaft—*

*Machinery Parts—*
(or Iron).

*Discs—*
Piston Heads.
Turbine Wheels.
Fly Wheels.
Pipe Flanges.

*Chain—*
Stud Link (or Iron).

*Finish—*

RAW FERROUS MATERIALS AND BY-PRODUCTS

*Ore—*
Red Oxide Paint.

*Pig Iron—*
For all Ferrous Products.

*Cement—*
Concrete.
Lining of Inner Bottom, and Decks.

*Slag—*
Concrete.
Mineral Wool.

*Coal—*
Fuel.
Carbons (Electrodes, Lamps, and Batteries).
Graphite (Paint, Lubrication, and Scale Remover).

*Coke*—
- Fillings.

*Tar*—
- Coatings.
- Benzene—
  - Dyes.
  - Motor Fuel.
- Toluol—
  - Signal Explosives, Dyes, Medicine.
- Naphtha—
  - Varnish, Paint, Stain, Linoleum.
- Carbolic Acid—
  - Disinfectants, Soap.
  - Bakelite—
    - Electric Insulation and Switches.
    - Varnishes.
    - Combs, Buttons.
- Lubricating Greases.
- Pitch—
  - Waterproofing, Asphalt, Paint.
  - Bitumastic Enamel, Solution, and Cement.
- Tarred Felt, Pipe Coatings.

*Coal Gas*—
- Ammonia—
  - Soaps.
  - Baking Powder.
  - Soldering.

*Zinc*—
- Plate and Fittings.
- White Paint.
- Sulphuric Acid—
  - Fire Extinguishers.

### *FABRICATED STEEL PRODUCTS*

*Parts*—
- Structural.
- Rivets.
- Bolts.

Screws.
Hardware.
Boilers.
Furnaces.
Machinery.

*Complete*—

Ships.
Barges.
Boats.

### *NON-FERROUS METALLIC PRODUCTS*

*Lead*—

Sheet.
Pipe.
Cast.
White Paint.
Red Paint.

*Tin*—

*Antimony*—

*Quicksilver*—

(largely for Anti-fouling Paint).

*Zinc*—

see By-Products.

*Silver*—

(for electroplating).

*Copper*—

Sheet.
Bar.
Pipe and Fittings.
Wire, incl. Insulation.
Tinned.

*Alloys*—

Bronze—

Manganese (Propeller and Antennae).
Tobin.

Other Compositions.

Brass—

Tubes (Condenser).

Pipe and Fittings.

Sheet.

Cast.

Hardware.

Instruments.

Solder—

Babbitt—

*Magnesia*—

Asbestos.

### *NON-METALLIC PRODUCTS*

*Quarried*—

Slate.

Marble.

Grindstones.

Sand.

Clay.

*Oils*—

Crude.

Gasolene.

Lubricating.

Linseed.

Glycerine.

*Ligneous*—

Cedar.

Redwood.

Cypress.

Fir.

Elm.

Ash.

Pine—

White.

Yellow.

- Spruce.
- Oak.
- Lignum Vitae.
- Cork.
- Rubber.
- Rosin.
- Charcoal.

*Refractory*—
- Fire-brick.

*Glass*—
- Portholes.
- Skylights.
- Windows.
- Table.
- Bulbs.
- Instruments.

*Ceramic*—
- China.
- Crockery.
- Tiling.
- Enamel.

*Fibrous*—
- Manilla (Rope).
- Hemp—
  - Cordage.
  - Gaskets.
  - Oakum.
- Cotton—
  - Twine.
  - Fabrics—
    - Canvas—
      - Deck.
      - Awnings.
      - Wick Stopwaters.
    - Flags.
- Furnishings (Linen, Wool, Hair, Felt).
- Kapok.

## APPENDIX C.

giving suggested topics to be considered in the further standardization of materials classified in Appendix B.

1. Each manufacturer should select the class of products in which he is interested, as applied to the parts classified in Appendix A, amplifying their subdivision as far as may be necessary to differentiate the essentials of each group.

2. A study should then be made, from the shipbuilder's standpoint, of the purpose for which, and the manner in which, each group of products is used, including storage and handling methods.

3. A study should also be made, from the manufacturer's standpoint, of the processes whereby each group of products is made, handled, and shipped.

4. A further study should be made of any requirements or methods intermediate between manufacturer and shipbuilder, for example:—

a. Materials handled by jobbers.
b. Materials used by equipment makers.
c. Transportation features.
d. Patented products.

5. Suitable literature should be adopted or prepared for distribution throughout the organizations of manufacturer, intermediary, and shipbuilder, in which the results of the above mentioned studies are clearly explained and applied to such topics as the following:—

a. General information regarding the ordering of each group of products in question.
b. Number and kind of documents to be furnished by Buyer to Seller.
c. Number and kind of documents to be furnished by Seller to Buyer, and where each should be sent.
d. Form of lists, with typical illustrations.
e. Desired time and sequence of shipment.
f. Minimum unit quantities.

g. Sizes readily obtainable, including lengths.
h. Grades of material, i.e. to what specifications.
i. Allowable tolerances in manufacture.
j. Finish of material.
k. Accessories to be included.
l. Percentage of spares desired and allowed.
m. Branding and marking.
n. Inspection of material, i.e. by whom and where.
o. Packing.
p. Routing.
q. Guaranty.

6. It will be noted that the word "standard" does not appear in the above topics, but a reduction of the products thereunder to the fewest number of groups, common to the largest number of makers and users, should result in standardization that will enable the user to prepare his specifications so as to secure the most suitable material, in the most convenient and economical form, and with the least delay.

## APPENDIX D.

showing quantities (in short tons) of rolled steel shapes of various thicknesses specified for the 1508 hulls covered by Appendix E, tabulated by Designs, Shipyards, and Hulls, with totals and averages.

*Note.* The normal popularity of Bulb Angles is not indicated by these tables, as their use had been restricted by the previously limited capacity for their production.

GRAND SUMMARY.

| | | Variety of | |
|---|---|---|---|
| | *Quantities* | *Shapes* | *Sections* |
| Plain Angles—Equal Leg | 330,600 | 14 | 66 |
| " " —Unequal Leg | 229,893 | 17 | 103 |
| Bulb Angles (restricted use) | 46,127 | 23 | 51 |
| Ship Channels | 405,545 | 16 | 55 |
| Structural Channels | 61,353 | 11 | 38 |
| I Beams | 13,857 | 23 | 30 |
| H Pillars | 5,492 | 7 | 38 |
| Tees | 6,330 | 13 | 13 |
| Zees | 1,454 | 7 | 9 |
| | 1,100,651 | 131 | 403 |

## Summary by Shapes.

*H Pillars*

| *Size* | *Quantity* |
|---|---|
| 14 | 1,874 |
| 12 | 2,193 |
| 10 | 518 |
| 8 | 851 |
| 6 | 20 |
| 5 | 10 |
| 4 | 26 |
| 7 | 5,492 |

*Tees*

| *Size* | *Quantity* |
|---|---|
| 6½ x 6½ | 5,760 |
| 6 x 5¼ | 51 |
| 6 x 4½ | 77 |
| 6 x 4 | 101 |
| 5 x 3 | 81 |
| 4½ x 3 | 65 |
| 4 x 5 | 27 |
| 4 x 4 | 16 |
| 4 x 4 | 126 |
| 4 x 3 | 7 |
| 4 x 3 | 5 |
| 3½ x 3½ | 13 |
| 3 x 3 | 1 |
| 13 | 6,330 |

*Zees*

| *Size* | *Quantity* |
|---|---|
| 6 | 83 |
| 5 | 22 |
| 4 | 1 |
| 3 | 13 |
| 3 | 569 |
| 3 | 13 |
| (Hatch) 2½ | 753 |
| 7 | 1,454 |

*Plain Angles—Equal Leg*

| *Size* | *Quantity* |
|---|---|
| 8 x 8 | 2,280 |
| 6 x 6 | 41,554 |
| 5 x 5 | 32,889 |
| 4½ x 4½ | 70 |
| 4 x 4 | 15,023 |
| 3½ x 3½ | 166,332 |
| 3 x 3 | 65,510 |
| 2½ x 2½ | 5,984.5 |
| 2¼ x 2¼ | 6 |
| 2 x 2 | 827.5 |
| 1¾ x 1¾ | 76 |
| 1½ x 1½ | 47.7 |
| 1¼ x 1¼ | 0.5 |
| 1 x 1 | 0.2 |
| 14 | 330,600.4 |

*Plain Angles—Unequal Leg*

| *Size* | *Quantity* |
|---|---|
| 8 x 6 | 882 |
| 8 x 3½ | 11,750 |
| 7 x 3½ | 18,957 |
| 6 x 4 | 20,916 |
| 6 x 3½ | 52,011 |
| 5 x 4 | 994 |
| 5 x 3½ | 9,671 |
| 5 x 3 | 18,423 |
| 4½ x 3 | 257 |
| 4 x 3½ | 5,438 |
| 4 x 3 | 56,469 |
| 3½ x 3 | 26,019 |
| 3½ x 2½ | 2,780 |
| 3 x 2½ | 4,987 |
| 3 x 2 | 44 |
| 2½ x 2 | 289 |
| 2½ x 1½ | 6 |
| 17 | 229,893 |

*Bulb Angles*

| *Size* | *Quantity* |
|---|---|
| 10 x 3½ | 10,111 |
| 9 x 3½ | 4,906 |
| 8 x 3½ | 9,435 |
| 8 x 3 | 955 |
| 7½ x 3½ | 277 |
| 7½ x 3 | 0.2 |
| 7 x 3½ | 7,274 |
| 7 x 3 | 6,037.2 |
| 6½ x 3½ | 32 |
| 6½ x 3 | 0.2 |
| 6 x 3½ | 33 |
| 6 x 3 | 7,020 |
| 5½ x 3 | 32 |
| 5 x 2½ | 14 |
| 14 | 46,126.6 |
| 9 | Extra Sets Rolls |
| 23 | |

SUMMARY BY SHAPES—*(cont'd)*

*Ship Channel*

| *Size* | *Quantity* |
|---|---|
| 12 x 4 | 31,270 |
| 12 x 3½ | 30,916 |
| 10 x 4 | 12,654 |
| 10 x 3½ | 51,622 |
| 10 x 3⅜ | 32,155 |
| 9 x 4 | 31,197 |
| 9 x 3½ | 104 |
| 8 x 3½ | 46,539 |
| 8 x 3 | 29 |
| 7 x 3½ | 35,780 |
| 7 x 3⅜ | 85,494 |
| 6 x 3⅝ | 316 |
| 6 x 3½ | 41,020 |
| 6 x 3 | 5,016 |
| 6 x 2½ | 1,373 |
| 4 x 2 | 60 |
| 16 | 405,545 |

*Structural Channels*

| *Size* | *Quantity* |
|---|---|
| 18 x 4 | 83 |
| 15 x 3½ | 15,785 |
| 13 x 4 | 3,053 |
| 12 x 3 | 28,890 |
| 10 x 2¾ | 1,147 |
| 9 x 2½ | 4,100 |
| 8 x 2⅜ | 6,603 |
| 7 x 2¼ | 1,221 |
| 6 x 2⅛ | 464 |
| 5 x 2 | 1 |
| 4 x 1⅝ | 6 |
| 11 | 61,353 |

*I Beams*

| *Size* | *Quantity* |
|---|---|
| 28 x 10 | 236 |
| 26 x 9½ | 582 |
| 24 x 9 | 4,565 |
| 24 x 7 | 916 |
| 20 x 7 | 189 |
| 20 x 6¼ | 133 |
| 18 x 11½ | 395 |
| 18 x 7½ | 1,827 |
| 18 x 7½ | 218 |
| 18 x 7 | 165 |
| 18 x 6 | 124 |
| 15 x 6¾ | 1,036 |
| 15 x 6 | 7 |
| 15 x 5½ | 2,374 |
| 12 x 5¼ | 628 |
| 12 x 5 | 200 |
| 10 x 4¾ | 101 |
| 9 x 4⅝ | 19 |
| 8 x 4 | 63 |
| 7 x 3¾ | 15 |
| 6 x 3⅜ | 55 |
| 5 x 3 | 1 |
| 4 x 2¾ | 8 |
| 23 | 13,857 |

## DISTRIBUTION

### Equal Leg Angles

| *Size of Shapes* | *Section Thickness* | *Wt. in pounds per ft.* | *Total Quantity Req'd* | *Used in Designs* | *Used in Yards* | *Used in Hulls* | *Average Quantity per Hull* |
|---|---|---|---|---|---|---|---|
| 8 x 8 | .75 | 38.9 | 227 | 2 | 2 | 32 | 7.1 |
| | .6875 | 35.8 | 952 | 5 | 11 | 105 | 9.05 |
| | .625 | 32.7 | 866 | 9 | 15 | 362 | 2.4 |
| | .5625 | 29.6 | 9 | 1 | 1 | 10 | 0.9 |
| | .50 | 26.4 | 226 | 5 | 6 | 370 | 0.6 |
| | | | 2,280 | 14 | 27 | 616 | 3.7 |
| 6 x 6 | .875 | 33.1 | 5 | 1 | 1 | 5 | 1.0 |
| | .8125 | 31.0 | 9 | 1 | 1 | 12 | 0.75 |
| | .75 | 28.7 | 1,018 | 11 | 18 | 547 | 1.86 |
| | .6875 | 26.5 | 1,115 | 4 | 3 | 125 | 8.9 |
| | .625 | 24.2 | 5,389 | 19 | 31 | 769 | 7.0 |
| | .5625 | 21.9 | 4,381 | 21 | 24 | 739 | 5.9 |
| | .50 | 19.6 | 14,739 | 26 | 43 | 1,012 | 14.6 |
| | .4375 | 17.2 | 13,071 | 27 | 52 | 1,094 | 11.9 |
| | .375 | 14.9 | 1,822 | 19 | 33 | 904 | 2.0 |
| | .3125 | 12.3 | 5 | 1 | 5 | 104 | 0.05 |
| | | | 41,554 | 31 | 52 | 1,448 | 28.7 |
| 5 x 5 | .75 | 23.6 | 595 | 3 | 6 | 156 | 3.8 |
| | .6875 | 21.8 | 492 | 6 | 11 | 122 | 4.03 |
| | .625 | 20.0 | 3,322 | 14 | 31 | 759 | 4.4 |
| | .5625 | 18.1 | 8,063 | 17 | 33 | 751 | 10.7 |
| | .50 | 16.2 | 12,247 | 31 | 52 | 1,377 | 8.9 |
| | .4375 | 14.3 | 7,031 | 25 | 42 | 1,176 | 6.0 |
| | .375 | 12.3 | 1,139 | 17 | 35 | 826 | 1.38 |
| | | | 32,889 | 31 | 52 | 1,377 | 23.9 |
| 4½ x 4½ | .625 | 17.8 | 70 | 1 | 1 | 10 | 7.0 |
| 4 x 4 | .75 | 18.5 | 17 | 2 | 2 | 72 | 0.24 |
| | .6875 | 17.1 | 975 | 6 | 10 | 258 | 3.8 |
| | .625 | 15.7 | 1,966 | 13 | 17 | 415 | 4.75 |
| | .5625 | 14.3 | 1,861 | 11 | 29 | 629 | 2.96 |
| | .50 | 12.8 | 7,434 | 31 | 51 | 1,306 | 5.7 |
| | .4375 | 11.3 | 1,984 | 24 | 36 | 870 | 2.3 |
| | .375 | 9.8 | 769 | 20 | 33 | 801 | 0.96 |
| | .3125 | 8.2 | 17 | 3 | 3 | 173 | 0.1 |
| | | | 15,023 | 31 | 55 | 1,442 | 10.4 |

EQUAL LEG ANGLES (Cont'd)

| Size of Shapes | Section Thick-ness | Wt. in pounds per ft. | Total Quantity Req'd | Used in Designs | Used in Yards | Used in Hulls | Average Quantity per Hull |
|---|---|---|---|---|---|---|---|
| 3½ x 3½ | .75 | 16.0 | 173 | 2 | 1 | 180 | 0.96 |
| | .6875 | 14.8 | 121 | 5 | 5 | 201 | 0.6 |
| | .625 | 13.6 | 3,509 | 21 | 36 | 787 | 4.5 |
| | .5625 | 12.4 | 5,629 | 17 | 27 | 589 | 9.6 |
| | .50 | 11.1 | 36,427 | 32 | 54 | 1,314 | 27.7 |
| | .4375 | 9.8 | 80,159 | 33 | 58 | 1,464 | 55.0 |
| | .375 | 8.5 | 38,143 | 32 | 57 | 1,486 | 25.7 |
| | .3125 | 7.2 | 591 | 13 | 26 | 615 | 0.96 |
| | .25 | 5.8 | 1,580 | 2 | 2 | 80 | 19.7 |
| | | | 166,332 | 34 | 60 | 1,508 | 110. |
| 3 x 3 | .625 | 11.5 | 55 | 3 | 3 | 146 | 0.38 |
| | .5625 | 10.4 | 367 | 5 | 5 | 226 | 1.62 |
| | .50 | 9.4 | 3,964 | 24 | 46 | 1,101 | 3.6 |
| | .4375 | 8.3 | 13,828 | 31 | 51 | 1,309 | 10.6 |
| | 375 | 7.2 | 32,764 | 34 | 58 | 1,405 | 23.3 |
| | .3125 | 6.1 | 5,864 | 30 | 52 | 1,276 | 4.6 |
| | .25 | 4.9 | 8,668 | 9 | 15 | 551 | 15.7 |
| | | | 65,510 | 34 | 59 | 1,481 | 43.2 |
| 2½ x 2½ | .50 | 7.7 | 3.5 | 1 | 1 | 70 | 0.05 |
| | .4375 | 6.8 | 7 | 2 | 3 | 17 | 0.41 |
| | .375 | 5.9 | 227 | 9 | 12 | 425 | 0.53 |
| | .3125 | 5.0 | 3,587 | 27 | 59 | 1,358 | 2.64 |
| | .25 | 4.1 | 2,128 | 25 | 46 | 1,138 | 1.87 |
| | .1875 | 3.07 | 32 | 4 | 9 | 144 | 0.22 |
| | | | 5,984.5 | 33 | 60 | 1,406 | 4.25 |
| 2¼ x 2¼ | .25 | 3.62 | 6 | 2 | 2 | 12 | 0.5 |
| 2 x 2 | .375 | 4.7 | 11 | 3 | 4 | 75 | 0.15 |
| | .3125 | 3.92 | 23 | 5 | 4 | 124 | 0.19 |
| | .25 | 3.19 | 753 | 20 | 36 | 1,031 | 0.73 |
| | .1875 | 2.44 | 40 | 6 | 6 | 170 | 0.24 |
| | .125 | 1.65 | 0.5 | 1 | 1 | 10 | 0.05 |
| | | | 827.5 | 20 | 37 | 1,063 | 0.78 |
| 1¾ x 1¾ | .375 | 4.1 | 10 | 1 | 5 | 104 | 0.1 |
| | .1875 | 2.12 | 66 | 2 | 6 | 254 | 0.26 |
| | | | 76 | 2 | 6 | 254 | 0.3 |

### Equal Leg Angles (Cont'd)

| *Size of Shapes* | *Section Thickness* | *Wt. in pounds per ft.* | *Total Quantity Req'd* | *Used in Designs* | *Yards* | *Hulls* | *Average Quantity per Hull* |
|---|---|---|---|---|---|---|---|
| 1½ x 1½ | .25 | 2.34 | 30 | 8 | 9 | 108 | 0.28 |
| | .1875 | 1.8 | 17 | 6 | 6 | 101 | 0.17 |
| | .125 | 1.23 | 0.7 | 3 | 3 | 124 | .006 |
| | | | 47.7 | 12 | 16 | 301 | 0.16 |
| 1¼ x 1¼ | .1875 | 1.48 | 0.5 | 1 | 1 | 2 | 0.25 |
| 1 x 1 | .1875 | 1.16 | .02 | 1 | 1 | 2 | 0.01 |

### Unequal Leg Angles

| *Size of Shapes* | *Section Thickness* | *Wt. in pounds per ft.* | *Total Quantity Req'd* | *Used in Designs* | *Yards* | *Hulls* | *Average Quantity per Hull* |
|---|---|---|---|---|---|---|---|
| 8 x 6 | .75 | 33.8 | 32 | 2 | 3 | 34 | 0.94 |
| | .6875 | 31.2 | 4 | 1 | 1 | 5 | 0.8 |
| | .625 | 28.5 | 106 | 3 | 3 | 85 | 1.25 |
| | .5625 | 25.7 | 28 | 3 | 7 | 179 | 0.16 |
| | .50 | 23.0 | 387 | 7 | 14 | 508 | 0.76 |
| | .4375 | 20.2 | 325 | 5 | 8 | 394 | 0.83 |
| | | | 882 | 12 | 18 | 567 | 1.5 |
| 8 x 3½ | .75 | 27.5 | 1 | 1 | 1 | 2 | 0.5 |
| | .6875 | 25.3 | 116 | 1 | 1 | 5 | 23.2 |
| | .625 | 23.2 | 1,339 | 10 | 12 | 404 | 3.3 |
| | .5625 | 21.0 | 3,152 | 2 | 1 | 180 | 17.5 |
| | .50 | 18.7 | 5.076 | 12 | 20 | 592 | 8.6 |
| | .4375 | 16.5 | 2,066 | 10 | 20 | 343 | 6.02 |
| | | | 11,750 | 17 | 31 | 723 | 16.2 |
| 7 x 3½ | .875 | 28.7 | 99 | 1 | 1 | 110 | 0.9 |
| | .75 | 24.9 | 1,765 | 4 | 10 | 235 | 7.5 |
| | .6875 | 23.0 | 921 | 1 | 1 | 70 | 13.2 |
| | .625 | 21.0 | 1,048 | 7 | 12 | 230 | 4.55 |
| | .5625 | 19.1 | 75 | 3 | 4 | 37 | 2.03 |
| | .50 | 17.0 | 5,791 | 13 | 23 | 744 | 7.8 |
| | .4375 | 15.0 | 5,203 | 17 | 27 | 721 | 7.2 |
| | .375 | 13.0 | 4,055 | 12 | 13 | 513 | 7.9 |
| | | | 18,957 | 29 | 44 | 1,142 | 16.5 |
| 6 x 4 | 1.00 | 30.6 | 1,758 | 5 | 13 | 152 | 11.5 |
| | .9375 | 28.9 | 529 | 2 | 4 | 49 | 10.8 |
| | .875 | 27.2 | 1,060 | 6 | 10 | 226 | 4.7 |
| | .8125 | 25.4 | 3,760 | 6 | 13 | 153 | 24.6 |
| | .75 | 23.6 | 2,552 | 8 | 15 | 239 | 10.7 |
| | .6875 | 21.8 | 1,350 | 8 | 11 | 158 | 8.5 |
| | .625 | 20.0 | 2,517 | 14 | 28 | 548 | 4.6 |
| | .5625 | 18.1 | 2,156 | 11 | 24 | 537 | 4.0 |
| | .50 | 16.2 | 2,799 | 20 | 37 | 794 | 3.5 |
| | .4375 | 14.3 | 1,553 | 11 | 27 | 666 | 2.34 |
| | .375 | 12.3 | 882 | 10 | 19 | 512 | 1.7 |
| | | | 20,916 | 31 | 59 | 1,379 | 15.2 |

UNEQUAL LEG ANGLES (Cont'd)

| *Size of Shapes* | *Section Thick-ness* | *Wt. in pounds per ft.* | *Total Quantity Req'd* | *Used in Designs* | *Yards* | *Hulls* | *Average Quantity per Hull* |
|---|---|---|---|---|---|---|---|
| 6 x 3½ | .8125 | 24.0 | 15 | 1 | 1 | 150 | 0.1 |
| | .75 | 22.4 | 267 | 5 | 6 | 229 | 1.17 |
| | .6875 | 20.6 | 533 | 3 | 6 | 82 | 6.5 |
| | .625 | 18.9 | 1,817 | 9 | 8 | 446 | 4.1 |
| | .5625 | 17.1 | 2,237 | 12 | 20 | 362 | 6.2 |
| | .50 | 15.3 | 10,149 | 29 | 54 | 1,197 | 8.5 |
| | .4375 | 13.5 | 14,555 | 31 | 58 | 1,369 | 10.6 |
| | .375 | 11.7 | 22,310 | 31 | 58 | 1,498 | 14.9 |
| | .3125 | 9.8 | 128 | 5 | 10 | 283 | 0.45 |
| | | | 52,011 | 34 | 60 | 1,508 | 34.6 |
| 5 x 4 | .8125 | 22.7 | 31 | 1 | 3 | 30 | 1.03 |
| | .625 | 17.8 | 7 | 2 | 2 | 10 | 0.7 |
| | .5625 | 16.2 | 636 | 6 | 7 | 330 | 1.9 |
| | .50 | 14.5 | 54 | 4 | 5 | 76 | 0.71 |
| | .4375 | 12.8 | 12 | 2 | 2 | 45 | 0.27 |
| | .375 | 11.0 | 254 | 5 | 10 | 344 | 0.74 |
| | | | 994 | 10 | 19 | 488 | 2.03 |
| 5 x 3½ | .75 | 19.8 | 34 | 3 | 4 | 163 | 0.21 |
| | .6875 | 18.3 | 126 | 1 | 1 | 70 | 1.8 |
| | .625 | 16.8 | 421 | 5 | 5 | 348 | 1.21 |
| | .5625 | 15.2 | 155 | 4 | 5 | 169 | 0.92 |
| | .50 | 13.6 | 1,504 | 17 | 31 | 799 | 1.9 |
| | 4375 | 12.0 | 3,638 | 25 | 42 | 925 | 3.9 |
| | .375 | 10.4 | 3,713 | 21 | 36 | 927 | 4.0 |
| | .3125 | 8.7 | 80 | 5 | 9 | 137 | 0.58 |
| | | | 9,671 | 30 | 50 | 1,173 | 8.25 |
| 5 x 3 | .6875 | 17.1 | 1,065 | 2 | 4 | 120 | 8.9 |
| | .625 | 15.7 | 15 | 1 | 1 | 150 | 0.1 |
| | .5625 | 14.3 | 4 | 1 | 1 | 2 | 2.0 |
| | .50 | 12.8 | 391 | 11 | 20 | 443 | 0.88 |
| | .4375 | 11.3 | 3,908 | 20 | 41 | 1,017 | 3.8 |
| | .375 | 9.8 | 10,780 | 28 | 60 | 1,434 | 7.5 |
| | .3125 | 8.2 | 2,260 | 17 | 30 | 884 | 2.56 |
| | | | 18,423 | 31 | 60 | 1,485 | 12.4 |
| 4½ x 3 | .375 | 9.1 | 176 | 2 | 2 | 24 | 7.3 |
| | .3125 | 7.7 | 81 | 2 | 4 | 24 | 3.4 |
| | | | 257 | 3 | 5 | 44 | 5.9 |

UNEQUAL LEG ANGLES (Cont'd)

| *Size of Shapes* | *Section Thickness* | *Wt. in pounds per ft.* | *Total Quantity Req'd* | *Used in Designs* | *Used in Yards* | *Used in Hulls* | *Average Quantity per Hull* |
|---|---|---|---|---|---|---|---|
| 4 x 3½ | .625 | 14.7 | 111 | 2 | 4 | 87 | 1.3 |
| | .5625 | 13.3 | 166 | 5 | 5 | 112 | 1.48 |
| | .50 | 11.9 | 300 | 16 | 25 | 696 | 0.43 |
| | .4375 | 10.6 | 4,309 | 16 | 27 | 616 | 7.0 |
| | .375 | 9.1 | 551 | 15 | 26 | 657 | 0.84 |
| | .3125 | 7.7 | 1 | 1 | 1 | 70 | 0.014 |
| | | | 5,438 | 21 | 36 | 916 | 5.9 |
| 4x 3 | .625 | 13.6 | 89 | 4 | 8 | 131 | 0.68 |
| | .5625 | 12.4 | 253 | 4 | 8 | 114 | 2.2 |
| | .50 | 11.1 | 537 | 13 | 32 | 537 | 1.0 |
| | .4375 | 9.8 | 14,338 | 32 | 54 | 1,343 | 10.7 |
| | .375 | 8.5 | 39,712 | 35 | 54 | 1,460 | 27.2 |
| | .3125 | 7.2 | 1,539 | 16 | 26 | 637 | 2.4 |
| | .25 | 5.8 | 1 | 1 | 1 | 2 | 0.5 |
| | | | 56,469 | 34 | 60 | 1,508 | 37.4 |
| 3½ x 3 | .625 | 12.5 | 3 | 1 | 1 | 110 | 0.027 |
| | .5625 | 11.4 | 1,591 | 5 | 6 | 242 | 6.6 |
| | .50 | 10.2 | 2,523 | 8 | 10 | 398 | 6.35 |
| | .4375 | 9.1 | 8,043 | 12 | 19 | 571 | 14.1 |
| | .375 | 7.9 | 6,064 | 24 | 49 | 1,019 | 5.95 |
| | .3125 | 6.6 | 2,237 | 16 | 29 | 709 | 3.16 |
| | .25 | 5.4 | 5,558 | 2 | 2 | 220 | 25.3 |
| | | | 26,019 | 27 | 49 | 1,099 | 23.7 |
| 3½ x 2½ | .50 | 9.4 | 3 | 1 | 1 | 4 | 0.75 |
| | .4375 | 8.3 | 24 | 3 | 3 | 136 | 0.18 |
| | .375 | 7.2 | 369 | 7 | 16 | 571 | 0.65 |
| | .3125 | 6.1 | 1,351 | 12 | 27 | 595 | 2.28 |
| | .25 | 4.9 | 33 | 3 | 12 | 322 | 0.1 |
| | | | 2,780 | 15 | 30 | 811 | 3.4 |
| 3 x 2½ | .50 | 8.5 | 15 | 2 | 2 | 120 | 0.125 |
| | .4375 | 7.6 | 73 | 3 | 4 | 149 | 0.49 |
| | .375 | 6.6 | 657 | 16 | 28 | 770 | 0.85 |
| | .3125 | 5.6 | 3,971 | 25 | 49 | 1,192 | 3.3 |
| | .25 | 4.5 | 271 | 10 | 13 | 416 | 0.65 |
| | | | 4,987 | 26 | 49 | 1,193 | 4.2 |

UNEQUAL LEG ANGLES (cont'd)

| *Size of Shapes* | *Section Thickness* | *Wt. in pounds per ft.* | *Total Quantity Req'd* | *Used in Designs* | *Used in Yards* | *Used in Hulls* | *Average Quantity per Hull* |
|---|---|---|---|---|---|---|---|
| 3 x 2 | .4375 | 6.8 | 6 | 1 | 1 | 14 | 0.43 |
| | .375 | 5.9 | 3 | 2 | 2 | 181 | 0.017 |
| | .3125 | 5.0 | 18 | 1 | 1 | 24 | 0.75 |
| | .25 | 4.1 | 17 | 3 | 3 | 39 | 0.44 |
| | | | 44 | 6 | 6 | 235 | 0.19 |
| 2½ x 2 | .375 | 5.3 | 19 | 3 | 4 | 268 | 0.07 |
| | .3125 | 4.5 | 170 | 6 | 16 | 368 | 0.46 |
| | .25 | 3.62 | 84 | 10 | 16 | 483 | 0.17 |
| | .1875 | 2.75 | 16 | 2 | 7 | 122 | 0.13 |
| | | | 289 | 13 | 24 | 651 | 0.44 |
| 2½ x 1½ | .25 | 3.19 | 1 | 2 | 2 | 115 | 0.01 |
| | .1875 | 2.12 | 5 | 1 | 1 | 110 | 0.045 |
| | | | 6 | 2 | 2 | 115 | 0.05 |

BULB ANGLES (restricted)

| *Size of Shapes* | *Section Thick-ness* | *Wt. in pounds per ft.* | *Total Quantity Req'd* | *Used in Designs* | *Yards* | *Hulls* | *Average Quantity per Hull* |
|---|---|---|---|---|---|---|---|
| 10 x 3½ | .675 | 33.0 | 533 | 2 | 2 | 21 | 25.4 |
| | .65 | 32.1 | 1,061 | 2 | 4 | 39 | 27.2 |
| | .625 | 31.1 | 1,680 | 2 | 3 | 32 | 52.5 |
| | .575 | 29.1 | 553 | 3 | 4 | 24 | 23.0 |
| 10 x 3½ | .55 | 27.9 | 119 | 1 | 1 | 4 | 29.7 |
| | .525 | 26.9 | 826 | 5 | 7 | 70 | 11.8 |
| | .50 | 25.9 | 4,084 | 9 | 11 | 107 | 38.2 |
| | .475 | 24.9 | 801 | 4 | 5 | 30 | 26.7 |
| | .45 | 23.9 | 454 | 4 | 4 | 34 | 13.3 |
| | | | 10,111 | 12 | 16 | 199 | 51.0 |
| 9 x 3½ | | 31.7 | 3 | 1 | 1 | 4 | 0.75 |
| | .65 | 29.5 | 27 | 1 | 2 | 4 | 6.75 |
| | .625 | 28.6 | 8 | 1 | 1 | 4 | 2.0 |
| 9 x 3½ | .55 | 25.7 | 8 | 2 | 4 | 6 | 1.33 |
| | .525 | 24.8 | 112 | 3 | 5 | 19 | 5.9 |
| | .50 | 23.9 | 244 | 5 | 5 | 35 | 7.0 |
| 9 x 3½ | .475 | 22.7 | 579 | 5 | 5 | 38 | 15.2 |
| | .45 | 21.8 | 3,077 | 6 | 8 | 70 | 44.0 |
| | .425 | 20.9 | 458 | 4 | 6 | 31 | 14.8 |
| | .40 | 20.0 | 390 | 6 | 5 | 38 | 10.3 |
| | | | 4,906 | 9 | 13 | 132 | 37.2 |
| 8 x 3½ | .65 | 26.5 | 324 | 1 | 2 | 20 | 16.2 |
| | .525 | 22.4 | 79 | 1 | 1 | 10 | 7.9 |
| | .50 | 21.7 | 633 | 4 | 7 | 50 | 12.7 |
| | .475 | 20.5 | 272 | 2 | 5 | 26 | 10.5 |
| | .45 | 19.6 | 2,652 | 8 | 11 | 78 | 34.0 |
| | .425 | 18.8 | 529 | 7 | 9 | 68 | 7.8 |
| | .40 | 18.0 | 4,946 | 9 | 12 | 103 | 48.0 |
| | | | 9,435 | 10 | 15 | 155 | 61.0 |
| 8 x 3 | .425 | 18.0 | 14 | 1 | 1 | 4 | 3.5 |
| | .40 | 17.2 | 941 | 4 | 7 | 108 | 8.7 |
| | | | 955 | 4 | 8 | 112 | 8.5 |

BULB ANGLES (cont'd)

| *Size of Shapes* | *Section Thick-ness* | *Wt. in pounds per ft.* | *Total Quantity Req'd* | *Used in Designs* | *Yards* | *Hulls* | *Average Quantity per Hull* |
|---|---|---|---|---|---|---|---|
| 7½ x 3½ | .50 | 20.4 | 29 | 1 | 1 | 4 | 7.25 |
| 7½ x 3½ | .425 | 17.8 | 10 | 1 | 1 | 4 | 2.5 |
| | .40 | 17.0 | 238 | 1 | 1 | 4 | 59.5 |
| | | | 277 | 1 | 1 | 4 | 69.3 |
| 7½ x 3 | .35 | 14.8 | 0.2 | 1 | 1 | 2 | 0.1 |
| 7 x 3½ | .575 | 21.6 | 88 | 1 | 2 | 13 | 6.8 |
| | .525 | 20.1 | 36 | 1 | 1 | 11 | 3.3 |
| | .475 | 18.7 | 439 | 2 | 2 | 10 | 43.9 |
| 7 x 3½ | .475 | 18.3 | 118 | 1 | 1 | 21 | 5.6 |
| 7 x 3½ | .45 | 17.6 | 1,204 | 9 | 11 | 107 | 11.2 |
| | .425 | 16.8 | 1,201 | 3 | 4 | 32 | 37.8 |
| | .40 | 16.2 | 1,824 | 7 | 10 | 123 | 14.8 |
| | .375 | 15.5 | 1,964 | 6 | 7 | 56 | 35.1 |
| | .35 | 14.8 | 400 | 4 | 3 | 28 | 14.3 |
| | | | 7,274 | 13 | 18 | 268 | 27.0 |
| 7 x 3 | .475 | 17.7 | 549 | 1 | 1 | 4 | 137.0 |
| | .45 | 16.9 | 1,479 | 3 | 3 | 26 | 57.0 |
| 7 x 3 | .425 | 16.0 | 6 | 1 | 2 | 4 | 1.5 |
| | .40 | 15.3 | 3 | 1 | 2 | 2 | 1.5 |
| | .375 | 14.6 | 4,000 | 2 | 5 | 160 | 25.0 |
| | .35 | 13.9 | 0.2 | 1 | 2 | 2 | 0.1 |
| | | | 6,037.2 | 3 | 8 | 195 | 31.0 |
| 6½ x 3½ | .425 | 16.7 | 27 | 1 | 1 | 10 | 2.7 |
| | .375 | 14.3 | 5 | 1 | 1 | 10 | 0.5 |
| | | | 32 | 1 | 1 | 10 | 3.2 |
| 6½ x 3 | .35 | 12.9 | 0.2 | 1 | 1 | 2 | 0.1 |
| 6 x 3½ | ? | 17.8 | 33 | 1 | 1 | 10 | 3.3 |

BULB ANGLES (cont'd)

| *Size of Shapes* | *Section Thick-ness* | *Wt. in pounds per ft.* | *Total Quantity Req'd* | *Used in Designs* | *Yards* | *Hulls* | *Average Quantity per Hull* |
|---|---|---|---|---|---|---|---|
| 6 x 3 | .50 | 16.2 | 51 | 3 | 4 | 29 | 1.76 |
| | .475 | 15.6 | 161 | 2 | 2 | 20 | 8.05 |
| | .45 | 14.9 | 784 | 6 | 13 | 145 | 5.4 |
| 6 x 3 | .425 | 14.1 | 627 | 7 | 7 | 108 | 5.8 |
| | .40 | 13.4 | 1,943 | 8 | 13 | 132 | 14.7 |
| | .375 | 12.8 | 3,450 | 9 | 17 | 139 | 24.8 |
| | .35 | 12.2 | 4 | 1 | 3 | 10 | 0.4 |
| | | | 7,020 | 18 | 30 | 464 | 15.1 |
| 5½ x 3 | .425 | 13.4 | 1 | 1 | 1 | 4 | 0.25 |
| 5½ x 3 | .40 | 12.5 | 25 | 1 | 1 | 6 | 4.2 |
| | .375 | 11.9 | 6 | 2 | 2 | 6 | 1.0 |
| | | | 32 | 2 | 3 | 12 | 2.7 |
| 5 x 2½ | .328 | 10.3 | 12 | 1 | 1 | 8 | 1.5 |
| | .313 | 10.0 | 2 | 1 | 1 | 1 | 2.0 |
| | | | 14 | 2 | 2 | 9 | 1.5 |

### SHIP CHANNELS

| *Size of Shapes* | *Section Thick-ness* | *Wt. in pounds per ft.* | *Total Quantity Req'd* | *Used in Designs* | *Yards* | *Hulls* | *Average Quantity per Hull* |
|---|---|---|---|---|---|---|---|
| 12 x 4 | .84 | 50.0 | 1,452 | 1 | 4 | 46 | 31.6 |
| | .75 | 46.3 | 249 | 3 | 3 | 59 | 4.2 |
| | .70 | 44.3 | 11,198 | 10 | 15 | 415 | 27.0 |
| | .595 | 40.0 | 7,566 | 11 | 18 | 470 | 16.1 |
| | .473 | 35.0 | 10,805 | 15 | 29 | 677 | 16.0 |
| | | | 31,270 | 15 | 31 | 753 | 41.5 |
| 12 x 3½ | .61 | 37.2 | 2,552 | 7 | 9 | 196 | 13.0 |
| | .50 | 32.7 | 17,179 | 15 | 21 | 627 | 27.4 |
| | .44 | 30.2 | 9,421 | 15 | 25 | 691 | 13.6 |
| | .375 | 29.3 | 1,764 | 5 | 6 | 54 | 32.7 |
| | | | 30,916 | 22 | 32 | 838 | 37.0 |
| 10 x 4 | .741 | 40.0 | 147 | 1 | 1 | 21 | 7.0 |
| | .65 | 36.9 | 2,101 | 4 | 6 | 254 | 8.3 |
| | .50 | 31.8 | 2,227 | 3 | 7 | 124 | 17.9 |
| | .447 | 30.0 | 8,179 | 4 | 4 | 134 | 61.0 |
| | | | 12,654 | 10 | 16 | 481 | 26.3 |
| 10 x 3½ | .675 | 33.2 | 78 | 2 | 2 | 39 | 2.0 |
| | .60 | 30.6 | 2,468 | 5 | 9 | 200 | 12,3 |
| | .55 | 28.9 | 20,796 | 9 | 19 | 434 | 48.0 |
| | .50 | 27.2 | 28,195 | 21 | 40 | 781 | 36.0 |
| | .475 | 26.4 | 15 | 3 | 7 | 129 | 0.12 |
| | .375 | 23.5 | 70 | 1 | 2 | 11 | 6.3 |
| | | | 51,622 | 21 | 42 | 925 | 56.0 |
| 10 x 3⅜ | .575 | 28.5 | 837 | 2 | 4 | 29 | 28.8 |
| | .50 | 26.0 | 443 | 7 | 10 | 283 | 1.57 |
| | .45 | 24.3 | 9,109 | 6 | 10 | 205 | 44.5 |
| | .40 | 22.6 | 1,054 | 4 | 13 | 231 | 4.6 |
| | .375 | 21.7 | 20,712 | 17 | 28 | 677 | 30.6 |
| | | | 32,155 | 19 | 38 | 852 | 37.8 |
| 9 x 4 | .65 | 34.7 | 1,485 | 4 | 6 | 91 | 16.3 |
| | .55 | 31.7 | 375 | 4 | 5 | 90 | 4.2 |
| | .45 | 28.6 | 29,337 | 11 | 14 | 300 | 97.5 |
| | | | 31,197 | 11 | 14 | 300 | 104.0 |

SHIP CHANNELS (cont'd)

| *Size of Shapes* | *Section Thickness* | *Wt. in pounds per ft.* | *Total Quantity Req'd* | *Used in Designs* | *Yards* | *Hulls* | *Average Quantity per Hull* |
|---|---|---|---|---|---|---|---|
| 9 x 3½ | .50 | 26.9 | 71 | 1 | 1 | 1 | 71.0 |
| | .45 | 25.4 | 31 | 1 | 1 | 10 | 3.1 |
| | ? | 21.8 | 2 | 1 | 1 | 2 | 1.0 |
| | | | 104 | 3 | 3 | 13 | 8.0 |
| 8 x 3½ | .625 | 27.2 | 301 | 3 | 10 | 151 | 2.0 |
| | .60 | 26.5 | 561 | 8 | 10 | 328 | 1.7 |
| | .55 | 25.2 | 7,082 | 2 | 7 | 107 | 66.0 |
| | .50 | 23.8 | 18,232 | 22 | 40 | 838 | 21.8 |
| | .425 | 22.7 | 14 | 2 | 2 | 28 | 0.5 |
| | .415 | 21.5 | 20,349 | 17 | 38 | 1,008 | 20.1 |
| | | | 46,539 | 26 | 42 | 1,060 | 44.0 |
| 8 x 3 | .40 | 19.3 | 2 | 1 | 2 | 11 | 0.18 |
| | .344 | 17.6 | 17 | 2 | 6 | 114 | 0.15 |
| | | | 29 | 2 | 6 | 114 | 0.25 |
| 7 x 3½ | .55 | 23.3 | 69 | 2 | 4 | 41 | 1.7 |
| | .50 | 22.1 | 138 | 7 | 10 | 158 | 0.9 |
| | .45 | 20.9 | 11,420 | 19 | 35 | 858 | 13.3 |
| | .40 | 20.2 | 444 | 2 | 3 | 12 | 37.0 |
| | .40 | 19.7 | 23,709 | 16 | 31 | 890 | 26.6 |
| | | | 35,780 | 24 | 45 | 1,178 | 30.4 |
| 7 x 3⅜ | .575 | 21.9 | 25 | 1 | 1 | 70 | 0.36 |
| | .438 | 18.6 | 55,403 | 22 | 38 | 957 | 57.8 |
| | .35 | 16.5 | 25,392 | 21 | 30 | 851 | 29.8 |
| | .313 | 15.6 | 4,674 | 10 | 18 | 631 | 7.4 |
| | | | 85,494 | 28 | 48 | 1,250 | 68.3 |
| 6 x 3⅝ | .535 | 21.5 | 133 | 2 | 3 | 121 | 1.1 |
| | .41 | 19.0 | 183 | 9 | 12 | 293 | 0.63 |
| | | | 316 | 10 | 14 | 325 | 0.98 |
| 6 x 3½ | .375 | 17.9 | 146 | 1 | 2 | 28 | 5.2 |
| | .35 | 15.0 | 40,874 | 29 | 48 | 1,238 | 29.6 |
| | | | 41,020 | 29 | 49 | 1,248 | 32.9 |
| 6 x 3 | .563 | 18.1 | 66 | 3 | 3 | 41 | 1.6 |
| | .313 | 13.0 | 4,950 | 7 | 10 | 519 | 9.5 |
| | | | 5,016 | 8 | 12 | 550 | 9.1 |
| 6 x 2½ | .313 | 12.5 | 1,373 | 3 | 9 | 202 | 6.8 |
| 4 x 2 | .394 | 10.1 | 60 | 1 | 2 | 13 | 4.6 |

STRUCTURAL CHANNELS

| Size of Shapes | Section Thickness | Wt. in pounds per ft. | Total Quantity Req'd | Used in Designs | Used in Yards | Used in Hulls | Average Quantity per Hull |
|---|---|---|---|---|---|---|---|
| 18 x 4 | .63 | 55 | 83 | 1 | 1 | 110 | 0.75 |
| 15 x 3½ | .818 | 55 | 240 | 2 | 7 | 184 | 1.3 |
| | .72 | 50 | 1,053 | 7 | 6 | 242 | 4.35 |
| | .622 | 45 | 76 | 2 | 2 | 152 | 0.5 |
| | .524 | 40 | 2,660 | 10 | 15 | 403 | 6.6 |
| | .426 | 35 | 722 | 2 | 4 | 22 | 32.8 |
| | .40 | 33 | 11,034 | 8 | 16 | 559 | 19.7 |
| | | | 15,785 | 14 | 21 | 640 | 24.6 |
| 13 x 4 | .678 | 45 | 538 | 2 | 6 | 114 | 4.7 |
| | .497 | 37 | 916 | 1 | 1 | 8 | 114.5 |
| | .452 | 35 | 1,337 | 3 | 2 | 43 | 31.1 |
| | .375 | 32 | 262 | 2 | 2 | 10 | 26.2 |
| | | | 3,053 | 7 | 12 | 161 | 18.9 |
| 12 x 3 | .758 | 40 | 15 | 1 | 1 | 22 | 0.68 |
| | .636 | 35 | 12,301 | 4 | 5 | 296 | 41.6 |
| | .513 | 30 | 8,493 | 4 | 6 | 289 | 29.4 |
| | .39 | 25 | 6,009 | 6 | 6 | 357 | 16.8 |
| | .28 | 20.5 | 2,072 | 6 | 8 | 331 | 6.3 |
| | | | 28,890 | 11 | 13 | 527 | 54.8 |
| 10 x 2¾ | .676 | 30 | 255 | | 2 | 154 | 1.65 |
| | .529 | 25 | 62 | 1 | 2 | 154 | 0.4 |
| | .382 | 20 | 753 | 4 | 6 | 287 | 2.62 |
| | .24 | 15 | 77 | 4 | 4 | 275 | 0.28 |
| | | | 1,147 | 6 | 8 | 302 | 3.8 |
| 9 x 2½ | .615 | 25.0 | 711 | 1 | 2 | 154 | 4.6 |
| | .452 | 20.0 | 3,386 | 2 | 3 | 159 | 21.3 |
| | .23 | 13.25 | 3 | 1 | 1 | 5 | 0.6 |
| | | | 4,100 | 2 | 3 | 159 | 25.8 |
| 8 x 2⅜ | .582 | 21.25 | 15 | 1 | 1 | 22 | 0.68 |
| | .49 | 18.75 | 1,801 | 2 | 3 | 164 | 11.0 |
| | .399 | 16.25 | 4,137 | 2 | 3 | 176 | 23.4 |
| | .307 | 13.75 | 586 | 2 | 3 | 164 | 3.57 |
| | .22 | 11.25 | 64 | 1 | 2 | 154 | 0.42 |
| | | | 6,603 | 3 | 4 | 186 | 35.5 |
| 7 x 2¼ | .423 | 14.75 | 225 | 2 | 2 | 21 | 10.7 |
| | .318 | 12.25 | 933 | 2 | 3 | 276 | 3.38 |
| | .21 | 9.75 | 63 | 1 | 1 | 5 | 12.6 |
| | | | 1,221 | 4 | 5 | 297 | 4.1 |
| 6 x 2⅛ | .563 | 15.5 | 307 | 1 | 2 | 154 | 2.0 |
| | .44 | 13.0 | 7 | 1 | 1 | 150 | 0.047 |
| | .318 | 10.5 | 123 | 3 | 7 | 118 | 1.04 |
| | .20 | 8.0 | 27 | 2 | 2 | 181 | 0.15 |
| | | | 464 | 3 | 9 | 271 | 1.7 |

STRUCTURAL CHANNELS (cont'd)

| Size of Shapes | Section Thickness | Wt. in pounds per ft. | Total Quantity Req'd | Used in Designs | Used in Yards | Used in Hulls | Average Quantity per Hull |
|---|---|---|---|---|---|---|---|
| 5 x 2 | .477 | 11.5 | 1 | 1 | 1 | 5 | 0.2 |
| 4 x 1⅝ | .325 | 7.25 | 1 | 1 | 1 | 4 | 0.25 |
| | .252 | 6.25 | 5 | 1 | 1 | 1 | 5.0 |
| | | | 6 | 1 | 2 | 5 | 1.2 |

I BEAMS

| Size of Shapes | Section Thickness | Wt. in pounds per ft. | Total Quantity Req'd | Used in Designs | Used in Yards | Used in Hulls | Average Quantity per Hull |
|---|---|---|---|---|---|---|---|
| 28 x 10 | .50 | 105 | 236 | 1 | 1 | 8 | 29.5 |
| 26 x 9½ | .46 | 90 | 582 | 1 | 1 | 8 | 72.7 |
| 24 x 9 | .476 | 74 | 4,565 | 2 | 2 | 118 | 38.7 |
| 24 x 7 | .631 | 90. | 233 | 1 | 1 | 150 | 1.55 |
| | .50 | 80 | 683 | 1 | 2 | 154 | 4.5 |
| | | | 916 | 1 | 2 | 154 | 5.9 |
| 20 x 7 | .60 | 80 | 189 | 1 | 1 | 70 | 2.7 |
| 20 x 6¼ | .50 | 65 | 133 | 2 | 2 | 220 | 0.6 |
| 18 x 11½ | .48 | 92 | 395 | 1 | 2 | 154 | 2.6 |
| 18 x 7½ | .32 | 52 | 1,827 | 1 | 1 | 70 | 26.1 |
| 18 x 7½ | .38 | 48 | 218 | 2 | 2 | 18 | 12.1 |
| 18 x 7 | .562 | 75 | 165 | 1 | 1 | 150 | 1.1 |
| 18 x 6 | .555 | 60 | 115 | 1 | 1 | 110 | 1.05 |
| | .46 | 55 | 9 | 1 | 1 | 12 | 0.75 |
| | | | 124 | 2 | 2 | 122 | 1.01 |
| 15 x 6¾ | .44 | 46 | 1,036 | 1 | 1 | 70 | 14.8 |
| 15 x 6 | .59 | 60 | 7 | 1 | 1 | 8 | 0.88 |
| 15 x 5½ | .656 | 55 | 45 | 2 | 5 | 48 | 0.94 |
| | .41 | 42 | 2,329 | 4 | 10 | 319 | 7.3 |
| | | | 2,374 | 6 | 15 | 367 | 6.5 |
| 12 x 5¼ | .46 | 40 | 628 | 6 | 8 | 269 | 2.3 |
| 12 x 5 | .436 | 35 | 187 | 3 | 3 | 48 | 3.9 |
| | .35 | 31.5 | 13 | 2 | 2 | 21 | 0.62 |
| | | | 200 | 5 | 5 | 69 | 2.9 |

I BEAMS (cont'd)

| Size of Shapes | Section Thick-ness | Wt. in pounds per ft. | Total Quantity Req'd | Used in Designs | Yards | Hulls | Average Quantity per Hull |
|---|---|---|---|---|---|---|---|
| 10 x 4¾ | .749 | 40 | 19 | 1 | 1 | 31 | 0.61 |
| | .602 | 35 | 9 | 1 | 1 | 8 | 1.13 |
| | .31 | 25 | 73 | 1 | 5 | 104 | 0.7 |
| | | | 101 | 3 | 7 | 143 | 0.7 |
| 9 x 4⅜ | .406 | 25 | 19 | 2 | 5 | 96 | 0.2 |
| 8 x 4 | .541 | 25.5 | 37 | 1 | 1 | 122 | 0.3 |
| | .27 | 18.0 | 26 | 2 | 4 | 132 | 0.2 |
| | | | 63 | 3 | 5 | 254 | 0.25 |
| 7 x 3¾ | .25 | 15 | 3 | 1 | 1 | 22 | 0.14 |
| 6 x 3⅜ | .352 | 14.75 | 55 | 2 | 4 | 83 | 0.66 |
| 5 x 3 | .21 | 9.75 | 1 | 2 | 2 | 18 | 0.06 |
| 4 x 2¾ | .337 | 9.5 | 8 | 1 | 1 | 31 | 0.26 |

H PILLARS

| *Size of Shapes* | *Section Thickness* | *Wt. in pounds per ft.* | *Total Quantity Req'd* | *Used in Designs* | *Used in Yards* | *Used in Hulls* | *Average Quantity per Hull* |
|---|---|---|---|---|---|---|---|
| 14 | 1.17 | 236 | 133 | 1 | 1 | 70 | 1.9 |
| | .82 | 162 | 206 | 2 | 3 | 84 | 2.5 |
| | .67 | 130.5 | 781 | 1 | 1 | 110 | 7.1 |
| | .63 | 122.5 | 96 | 1 | 1 | 22 | 4.35 |
| | .59 | 114.5 | 64 | 2 | 2 | 27 | 2.37 |
| | .55 | 106.5 | 49 | 1 | 1 | 5 | 9.8 |
| | .51 | 99 | 67 | 1 | 1 | 70 | 0.96 |
| | .47 | 91 | 208 | 2 | 2 | 27 | 7.7 |
| | .43 | 83.5 | 270 | 1 | 1 | 150 | 1.8 |
| | | | 1,874 | 6 | 5 | 371 | 5.1 |
| 12 | .78 | 132.5 | 164 | 2 | 4 | 25 | 6.55 |
| | .74 | 125.5 | 396 | 2 | 3 | 164 | 2.41 |
| | .70 | 118.5 | 63 | 1 | 1 | 70 | 0.9 |
| | .67 | 112 | 387 | 5 | 8 | 259 | 1.5 |
| | .63 | 105 | 150 | 4 | 7 | 189 | 0.8 |
| | .59 | 98.5 | 113 | 2 | 4 | 25 | 4.5 |
| | .55 | 91.5 | 188 | 3 | 5 | 175 | 1.07 |
| | .51 | 84.5 | 465 | 3 | 5 | 244 | 1.9 |
| | .43 | 71.5 | 246 | 2 | 3 | 224 | 1.1 |
| | .39 | 64.5 | 21 | 1 | 1 | 70 | 0.3 |
| | | | 2,193 | 7 | 10 | 389 | 5.6 |
| 10 | .63 | 88.5 | 11 | 1 | 1 | 10 | 1.1 |
| | .59 | 82.5 | 15 | 2 | 3 | 24 | 0.6 |
| | .55 | 77 | 42 | 3 | 4 | 46 | 0.9 |
| | .47 | 65.5 | 112 | 3 | 5 | 39 | 2.9 |
| | .43 | 59.5 | 151 | 4 | 6 | 54 | 2.8 |
| | .39 | 54 | 168 | 3 | 6 | 181 | 0.93 |
| | .36 | 49 | 19 | 1 | 1 | 22 | 0.86 |
| | | | 518 | 8 | 12 | 248 | 2.1 |
| 8 | .63 | 71.5 | 483 | 2 | 3 | 121 | 4.0 |
| | .55 | 62 | 7 | 2 | 4 | 25 | 0.28 |
| | .51 | 57.5 | 14 | 1 | 2 | 11 | 1.27 |
| | .47 | 53 | 13 | 1 | 2 | 14 | 0.93 |
| | .43 | 48 | 52 | 2 | 3 | 16 | 3.3 |
| | .39 | 43.5 | 59 | 4 | 6 | 40 | 1.5 |
| | .35 | 39 | 135 | 4 | 6 | 63 | 2.14 |
| | .31 | 34.5 | 33 | 3 | 4 | 29 | 1.14 |
| | .31 | 32 | 55 | 2 | 4 | 31 | 1.8 |
| | | | 851 | 8 | 11 | 205 | 4.1 |
| 6 | .313 | 23.8 | 20 | 2 | 4 | 26 | 0.77 |
| 5 | .313 | 18.7 | 10 | 2 | 3 | 24 | 0.42 |
| 4 | .313 | 13.6 | 26 | 2 | 3 | 18 | 1.44 |

TEES

| Size of Shapes | Section Thickness | Wt. in pounds per ft. | Total Quantity Req'd | Used in Designs | Used in Yards | Used in Hulls | Average Quantity per Hull |
|---|---|---|---|---|---|---|---|
| 6½ x 6½ | .45 | 19.8 | 5,760 | 14 | 19 | 409 | 14.1 |
| 6 x 5¼ | 1.375 | 39.4 | 51 | 1 | 1 | 32 | 1.59 |
| 6 x 4½ | 1.06 | 28.2 | 77 | 2 | 2 | 42 | 1.83 |
| 6 x 4 | .5625 | 15.6 | 101 | 4 | 4 | 26 | 3.9 |
| 5 x 3 | ? | 13.6 | 81 | 4 | 4 | 48 | 1.7 |
| 4½ x 3 | .4375 | 9.8 | 65 | 2 | 3 | 85 | 0.77 |
| 4 x 5 | ? | 11.9 | 27 | 1 | 1 | 32 | 0.84 |
| 4 x 4 | .5625 | 13.5 | 16 | 1 | 1 | 8 | 2.0 |
| 4 x 4 | .4375 | 10.5 | 126 | 3 | 8 | 122 | 1.03 |
| 4 x 3 | .4375 | 9.2 | 7 | 1 | 1 | 46 | 0.15 |
| 4 x 3 | .375 | 7.8 | 5 | 1 | 1 | 46 | 0.11 |
| 3½ x 3½ | .4375 | 9.2 | 13 | 1 | 1 | 22 | 0.59 |
| 3 x 3 | .375 | 6.7 | 1 | 1 | 1 | 8 | 0.13 |

ZEES

| Size of Shapes | Section Thickness | Wt. in pounds per ft. | Total Quantity Req'd | Used in Designs | Used in Yards | Used in Hulls | Average Quantity per Hull |
|---|---|---|---|---|---|---|---|
| 6 | .375 | 15.7 | 12 | 1 | 1 | 10 | 1.2 |
| | ? | 14.6 | 71 | 1 | 1 | 12 | 5.9 |
| | | | 83 | 1 | 1 | 12 | 6.9 |
| 5 | .3125 | 11.6 | 22 | 1 | 1 | 32 | 0.69 |
| 4 | .375 | 12.5 | 1 | 1 | 2 | 13 | 0.08 |
| 3 | .50 | 12.6 | 13 | 1 | 1 | 5 | 2.6 |
| 3 | .4375 | 11.5 | 129 | 1 | 1 | 30 | 4.3 |
| | .375 | 9.8 | 440 | 3 | 8 | 169 | 2.6 |
| | | | 569 | 3 | 8 | 199 | 2.8 |
| 3 | .3125 | 8.5 | 13 | 2 | 3 | 19 | 0.7 |
| 2½ | .50 | 13.6 | 753 | 5 | 7 | 141 | 5.3 |

## Appendix E.

showing variety of rolled steel shapes and section thicknesses (tabulated by Designs and Shipyards) specified for the 1508 vessels covered by Report of Oct. 15, 1918, to Emergency Fleet Corporation.

| *Approx. D.W.T.* | *E.F.C. Design* | *Shipyard* | *Number of Ships* | *Variety of Shapes* | *Variety of Section Thicknesses* | |
|---|---|---|---|---|---|---|
| | | CARGO SHIPS | | | | |
| 12,500 | Req. | Pennsylvania S.B. | 11 | 21 | 53 | |
| 11,925 | Req. | New York S.B. | 2 | 33 | 77 | |
| 11,800 | 56 | Bethl.—Alameda | 18 | 36 | 80 | |
| 10,000 | 18 | Sun S.B. | 12 | 24 | 51 | |
| 9,600 | 37 | Federal S.B. | 30 | 25 | 67 | Approx. |
| | | Carolina S.B. | 12 | 29 | 71 | |
| | | Doullut & Williams | 8 | 31 | 85 | |
| 9,500 | 27 | Oscar Daniels | 10 | 33 | 72 | Approx. |
| | Req. | Cramp S.&E.B. | 2 | 31 | 86 | |
| 9,400 | 15 | Groton | 6 | 22 | 52 | |
| | | Virginia | 12 | 22 | 52 | Approx. |
| | | Moore S.B. | 25 | 21 | 49 | |
| | | Pacific Coast S.B. | 10 | 25 | 56 | |
| | | Union Constr'n | 10 | 24 | 50 | |
| | | Seattle N. Pacific | 10 | 23 | 53 | |
| | | Standifer | 10 | 16 | 44 | |
| | 79 | Skinner & Eddy | 46 | 26 | 72 | |
| 9,000 | 25 | Newburgh | 10 | 35 | 98 | Approx. |
| | | Merrill-Stevens | 6 | 35 | 98 | Approx. |
| | | Pensacola | 10 | 29 | 86 | |
| | | Chester | 18 | 35 | 98 | |
| | | Merchant | 60 | 35 | 98 | |

| *Approx. D.W.T.* | *E.F.C. Design* | *Shipyard* | *Number of Ships* | *Variety of Shapes* | *Section Thicknesses* | |
|---|---|---|---|---|---|---|
| | | CARGO SHIPS (cont'd) | | | | |
| 8,800 | 19 | Atlantic | 10 | 26 | 60 | |
| | | Long Beach | 8 | 20 | 52 | |
| | | Southwestern | 10 | 27 | 65 | |
| | | Western Pipe | 18 | 24 | 64 | |
| | 16 | Groton | 6 | 34 | 87 | Approx. |
| | | Baltimore D.D. | 8 | 34 | 87 | |
| | 13 | Los Angeles | 30 | 22 | 45 | |
| | | Columbia River | 32 | 34 | 73 | |
| | | Northwest Steel | 31 | 33 | 63 | |
| | | Skinner & Eddy | 31 | 26 | 66 | |
| | 66 | Duthie | 22 | 36 | 88 | |
| | 80 | Ames | 25 | 27 | 57 | |
| 7,500 | 17 | Downey | 10 | 27 | 54 | |
| | 14 | Seattle Constr'n | 21 | 17 | 36 | |
| | 22 | Hog Island | 110 | 36 | 118 | |
| | Req. | Pennsylvania S.B. | 2 | 32 | 60 | |
| 7,400 | 63 | Standard | 23 | 25 | 56 | |
| | | Beth.—Sp.P.&H.&H. | 9 | 28 | 84 | |
| 5,350 | 43 | Hanlon | 8 | 26 | 54 | |
| 5,000 | 23 | Bayles | 4 | 39 | 106 | |
| | | Submarine | 150 | 42 | 118 | |
| | Req. | New Jersey S.B. | 12 | 23 | 46 | |
| 4,350 | Req. | Pusey & Jones | 10 | 23 | 48 | |
| 4,200 | 60 | American S.B. | 60 | 20 | 46 | |
| | | Great Lakes | 24 | 24 | 42 | |
| 4,050 | 60 | American S.B. | 60 | 20 | 46 | Approx. |
| | 74 | Globe | 5 | 16 | 29 | |
| | | Great Lakes | 24 | 18 | 29 | |
| | | Manitowoc | 12 | 17 | 31 | |
| | | McDougall-Duluth | 15 | 16 | 29 | Approx. |
| | | Saginaw | 12 | 16 | 29 | Approx. |
| | | Toledo | 16 | 19 | 45 | |

| *Approx. D.W.T.* | *E.F.C. Design* | *Shipyard* | *Number of Ships* | *Variety of Section Shapes* | *Variety of Section Thicknesses* | |
|---|---|---|---|---|---|---|
| | | CARGO SHIPS (cont'd) | | | | |
| 3,800 | 49 | Albina | 13 | 19 | 37 | |
| 3,500 | 20 | American S.B. | 56 | 19 | 43 | Approx. |
| | | Globe | 10 | 19 | 43 | |
| | | McDougall-Duluth | 10 | 19 | 43 | Approx. |
| | | Saginaw | 12 | 21 | 37 | |
| | | Toledo | 8 | 20 | 43 | |
| | Req. | Staten Island | 5 | 21 | 43 | |
| 3,400 | 44 | Manitowoc | 14 | 21 | 38 | |
| | | CARGO—TRANSPORTS | | | | |
| 10,000 | 29 | New York S.B. | 3 | 24 | 56 | |
| 8,000 | 24 | Hog Island | 70 | 32 | 129 | |
| 5,000 | Req. | Cramp S.&E.B. | 3 | 25 | 55 | |
| | | COLLIER | | | | |
| 8,600 | Req. | New York S.B. | 5 | 30 | 60 | |
| | | TANKERS | | | | |
| ? | Navy | Newport News | 8 | 28 | 59 | |
| 12,650 | Req. | New York Ship | 4 | 34 | 91 | |
| 10,300 | 59 | Baltimore D.D. | 12 | 22 | 61 | |
| 10,150 | Req. | Sun S.B. | 8 | 30 | 56 | |
| 10,000 | 47 | Bethl.—Sp.P.&Un. | 28 | 29 | 62 | |
| | 41 | Moore S.B. | 6 | 19 | 38 | |
| 9,800 | Req. | Texas S.S. | 4 | 36 | 88 | |
| 7,500 | 31 | Bethl.—H.&H. | 3 | 39 | 83 | |
| | | Terry S.B. | 10 | 39 | 83 | Approx. |
| 6,000 | 58 | Baltimore D.D. | 6 | 19 | 33 | |
| 4,800 | Req. | Bethlehem—Moore | 1 | 23 | 41 | |

| *Approx. D.W.T.* | *E.F.C. Design* | *Shipyard* | *Number of Ships* | *Variety of Section Shapes* | *Variety of Section Thicknesses* | |
|---|---|---|---|---|---|---|
| | | TUGS | | | | |
| Ocean | 35 | Bayles | 2 | 10 | 13 | |
| | | Bethlehem—Moore | 20 | 12 | 14 | |
| | | Newburgh | 3 | 12 | 16 | |
| | | Providence | 10 | 11 | 12 | |
| | | Whitney | 10 | 9 | 11 | |
| Harbor | 36 | Johnson | 6 | 8 | 12 | |
| | | Northwest Eng. | 2 | 8 | 12 | Approx. |